Urban Water Recycling Feasibility Assessment Guidebook

California Urban Water Agencies
with assistance from
WateReuse Association of California

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Guidebook on Water Recycling Feasibility Assessment

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This guidebook on water recycling feasibility was prepared for the California Urban Water Agencies with assistance from the WateReuse Association of California. A Project Advisory Committee, chaired by Ken Weinberg of the San Diego County Water Authority, reviewed and edited the working draft copy of the guidebook. Members of the Project Advisory Committee included:

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PREFACE

The California Urban Water Agencies and the WateReuse Association of California have sponsored the preparation of this Guidebook on Water Recycling. This Guidebook is to be used by a public water supply or wastewater disposal agency that may be considering developing a water recycling project. The purpose of the Guidebook is to provide an overview of the planning process for evaluating the feasibility of a water recycling project and the critical implementation issues. The Guidebook provides a method for developing answers to the following questions:

- How do you determine if there is a need?
- How much will it cost?
- Who has to be involved?
- What are the regulatory issues and hurdles?
- How to involve the public and other interested parties in the evaluation of the project feasibility?
- What are the next steps to determine feasibility?

The Guidebook addresses all the issues that should be considered, the technical and economic questions that should be addressed, and provides several case study examples for comparison purposes. It briefly discussed issues and concerns to include in developing and evaluating a water recycling concept to the point of determining feasibility and potential financing mechanisms.

This Guidebook does not give specific answers in determining project feasibility, because every recycled project is different. The specific project answers will depend upon your agency's unique geography, institutional and financial factors, number and types of potential users, and size and quality of wastewater flows.

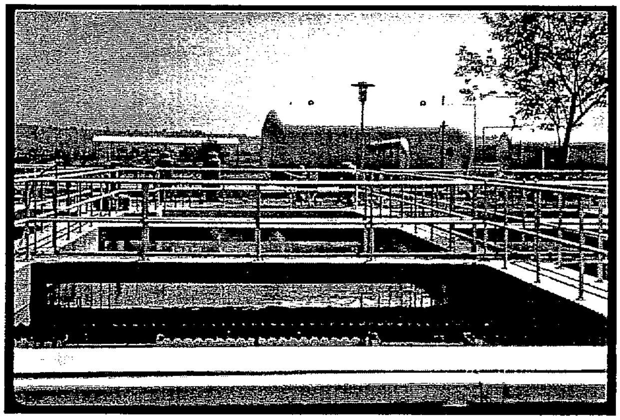
Depending on the agency's resources, it may be advisable to hire outside consultant experts with experience in the development and implementation of water recycling projects. On the other hand, a preliminary analysis may indicate that no viable potential water recycling project exists and that other water supply options and wastewater disposal plans are more appropriate.

Section

1 INTRODUCTION

1.1 WATER RECYCLING

Water recycling is an important part of the water resources management mix in California. Water recycling (sometimes referred to as water reclamation or water reuse) is a proven technology and can be an effective alternative supply for meeting urban, agricultural, and environmental water needs. Recycled water projects can extend existing water supplies, decrease wastewater disposal costs, improve receiving water quality, reduce discharge of pollutants to the aquatic environment, save user costs for water, and conserve energy.



Today in California, over 250 water recycling projects are in operation. Many more are planned as California's population continues to grow and demands on limited water supplies increase. Recurring drought conditions have heightened the public awareness of the need to use water efficiently. Federal, state, and local agencies have responded by developing new innovative programs to finance water recycling projects.

1.2 WHY A GUIDEBOOK?

This Guidebook establishes a step-by-step approach in determining the feasibility of a potential water recycling project. It identifies and helps streamline the complexities associated with analyzing and launching a successful project. Use of this Guidebook will lead to better coordination among water and wastewater utilities, project sponsors, and funding sources and ensure compliance with the Urban Water Management

Planning Act. It also promotes California legislative goals for water recycling, integrated resources planning at a local level, and a uniform and consistent approach to evaluating recycling projects.

This Guidebook is intended to be used by water and wastewater professionals who are evaluating a water recycling project. Additionally, policy makers, regulators, funding agencies, and consultants should find this Guidebook a useful tool to help determine whether or not a proposed water recycling project is cost-effective, financially feasible, and a viable water supply option.

1.3 WATER RECYCLING BENEFITS

Water recycling projects have the potential to extend existing water supplies, lessen the demand on sensitive water bodies, lower the cost of developing new water supplies, reduce wastewater treatment and disposal costs, lessen the discharge of pollutants to the environment, and provide a high quality supply of water to serve a variety of beneficial uses. Another benefit is that recycled water can be developed in phased project expansions, which offers tremendous flexibility as to timing of water supply investments.

1.4 CALFED BAY-DELTA WATER USE EFFICIENCY PROGRAM

An expanded statewide supply of recycled water would reduce the need for additional diversions from the Bay-Delta system. All of the alternatives being studied by the CALFED Bay-Delta Program include water recycling as a water use efficiency element. CALFED's Water Use Efficiency Program is based upon the notion that before Californians pay to develop new water supplies, existing supplies must be used as efficiently as possible.

An increased supply of recycled water would provide meaningful contributions to the Bay-Delta solution. Specifically, an expanded recycling program will reduce the need for diversons from the Bay-Delta watershed which would promote carryover storage, increase water availability, improve Delta water quality, and help restore Delta ecosystem vitality. To the extent that water recycling is able to reasonably achieve specific CALFED objectives, CUWA recommends that CALFED evaluate such opportunities on par with other options being considered to achieve the same objectives.

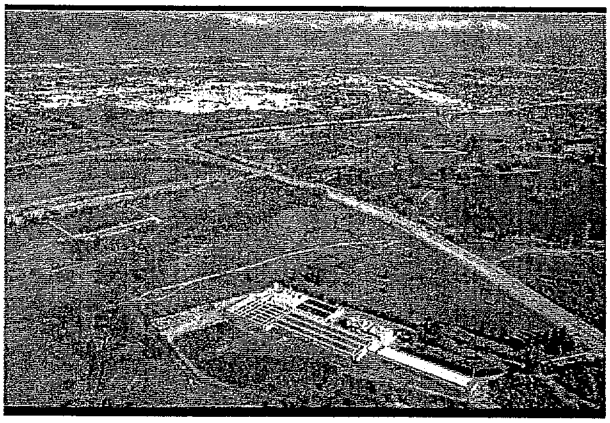
Water recycling projects can be expensive undertakings which, when viewed solely from the local or regional perspective, may not be cost-effective. CALFED may be in a position to ensure the long-term success of an expensive statewide water recycling program. CUWA has recommended that such projects be eligible for direct financial support by the CALFED agencies. Local and regional agencies implementing water recycling projects that further CALFED objectives should consider the potential for financial support from the CALFED agencies as a means of enhancing the feasibility of water recycling.

1.5 IMPLEMENTATION ISSUES

There are a number of issues to be resolved before implementing a water recycling projects can occur. Reclaimed water quality guarantees and water rights must be dealt with. Financing and the rates and charges associated with a project can become complex because of the multi-jurisdictional nature of water recycling projects. Finally, public support is critical in implementing a water recycling project. Public surveys indicate broad public support for recycling, but community involvement in the project development and operation is required to ensure support at the local level. These issues and methods to deal with them are discussed in detail in the following sections with specific case studies and examples.

1.6 HISTORY

As far back as 1896, state health authorities have regulated the use of wastewater for the irrigation of special crops. Since 1928, the California Constitution has included language to prohibit waste or unreasonable use of water. Groundwater recharge with recycled water has been encouraged. For example, a significant portion of the groundwater extracted from the Santa Ana River Basin is recycled water. The landmark Whittier Narrows Water Reclamation Plant went into operation in 1962, providing recycled water for replenishment of the Central Groundwater Basin in Los Angeles County. In 1977, the legislature amended the water code to prohibit the use of potable water for landscape irrigation when recycled water is available that meets certain conditions of quality and price.



1.7 CURRENT STATUS

California public policy places a strong emphasis on water recycling. (California Water Code, Section 13550) in lieu of freshwater for non-potable uses (e.g., irrigation, industrial cooling towers) provides that the State require the maximum use of recycled water. California Water Recycling Law (California Water Code, Section 13510) declares that the people of California have a primary interest in developing water recycling facilities to meet the reliable water needs of the State to augment existing surface and groundwater resources. California Water Code, Section 13512 states that it is the intent of the Legislature and the State to undertake steps to encourage development and beneficial use of water recycling facilities. The Water Recycling Act of 1991 (California Water Code, Section 13577) sets recycling goals of 700,000 acre-feet of water annually by year 2000 and 1,000,000 acre-feet annually by year 2010.

Further legislative and regulatory provisions reiterate the general tenets of California Water Reclamation Law, specifically focusing on coastal areas. In coastal zone areas, recycling treated water that otherwise would have been disposed into the ocean is recognized as the creation of a "new" supply for that region. California Water Code, Section 13142(e) urges wastewater treatment agencies located in the coastal zone to recycle and reuse as much of their treated effluent as practicable.

Additionally, the State Water Resources Control Board (SWRCB) requires a periodic review of water rights permits and licenses and waste discharge permits. For example, water right permittees and licenses are required to report periodically on the potential to use recycled water for all or part of their needs.[1] The SWRCB, when acting on a water right permit application, may reduce the amount of water requested and require the applicant to adopt a water recycling program.[2] Waste Discharge permits are subject to renewal every five years. When an applicant in a water-short area proposes a discharge of once-used wastewater, the Regional Water Quality Control Board (RWQCB) requires applicants to explain why the effluent is not being reclaimed for further beneficial use. [3]

The objective of each of these policies is to ensure that local agencies responsible for water supply and wastewater treatment and disposal are effectively planning for the development of recycled water. This Guidebook provides suggestions and recommendations on approaches to the planning of a water recycling project.

1.8 REGIONAL COORDINATION

As supplies of potable water become limited, regional planning is being utilized to identify, develop and coordinate water reuse. In both northern and southern California, multi-agency efforts are underway to expand the use of recycled water as a new water supply. The Bay Area Regional Water Recycling Program (BARWRP), a collaboration of federal, state, and local agencies, is preparing a Master Plan to maximize the water yield

1 Cal. Code Regs., Tit 23,§ 848.
2 Cal. Code Regs., Tit 23,§ 780.
3 "In the matter of the Sierra Club, San Diego Chapter," State Water Board Order 84-7.

from potential recycled water production in the Bay Area. Wastewater flows in the Bay Area are predicted to reach 650,000 acre-feet per year by the year 2020. Similarly, the Southern California Comprehensive Water Reclamation and Reuse Study (SCCWRRS) is examining the development of a regional reclamation system to provide recycled water to the southern California coastal and inland valley areas. This cooperative effort brings together water agencies from Ventura, Los Angeles, Orange, Riverside, San Bernardino, and San Diego counties.

1.8.1 Bay Area Regional Water Recycling Program

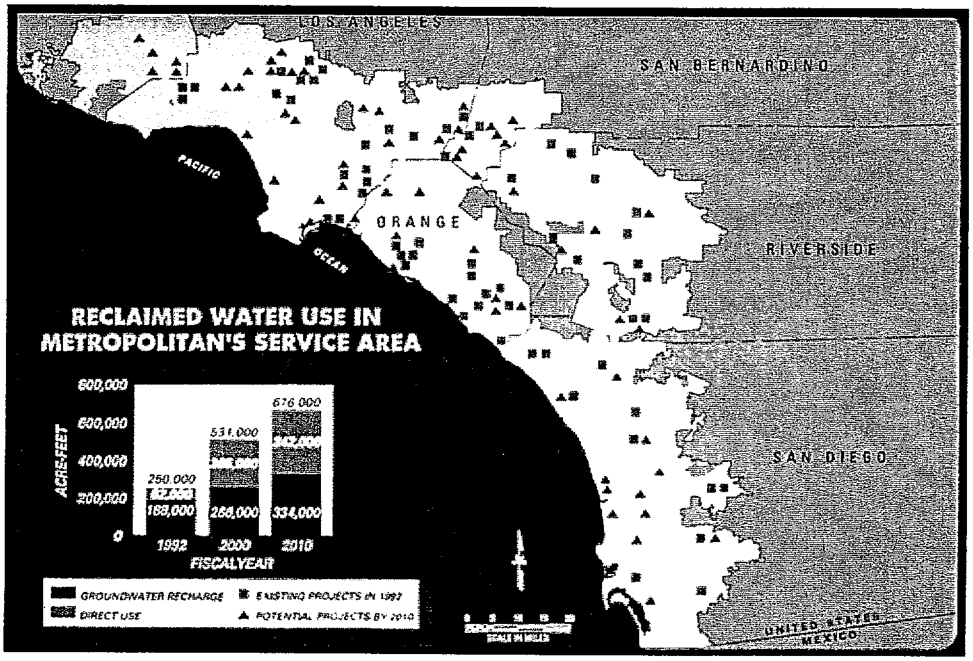
The BARWRP is a partnership of agencies committed to maximizing water recycling in the Bay Area. This partnership of Bay Area water and wastewater agencies, the California Department of Water Resources (DWR), and the United State Bureau of Reclamation (USBR) has begun preparation of a Bay-Area-wide Master Plan for water recycling highly treated wastewater to provide a safe, reliable, and drought-proof new water supply.

The BARWRP Master Plan is anticipated to lead to identification of regional supply benefits not previously recognized through local water recycling assessments. This regional approach will maximize the water yield from the potential recycled water production capacity that is expected to reach 650,000 acre-feet per year by the year 2020. A forerunner to the regional approach being taken by BARWRP is the South Bay Water Recycling Program, a joint venture between the cities of San Jose, Santa Clara, and Milpitas, with additional support from the Santa Clara Valley Water District. This program will free up fresh water for other purposes and decrease the discharge of treated wastewater into the Bay, thereby restoring natural salt levels in the salt-water marshes of the region. Over 70 percent of the recycled water will be used for irrigating and landscaping parks, schools, and golf courses. The remaining recycled water will be used for agriculture and industry. Other similar opportunities for water recycling on a regional or sub-regional basis are being identified in the BARWRP Master Plan.

1.8.2 Southern California Comprehensive Water Reclamation and Reuse Study

In 1993, the USBR, seven southern California municipalities and water agencies and the DWR adopted a plan of study to evaluate the feasibility of a regional water reclamation plan. Regional planning would take advantage of potential surpluses in reclaimed water which could serve needs in areas throughout the region.

The plan of study calls for a three-part, 6-year comprehensive effort, the SCCWRRS, to identify a regional reclamation system and develop potential capital projects. The ultimate objective is to promote efficient use of total water resources by increasing the use of reclaimed water. The SCCWRRS will determine the feasibility of developing a long-range reclaimed water supply and management program for the southern California coastal plain and inland valley areas.



The DWR, and the following seven local agencies, have made the financial commitment to conduct this comprehensive regional planning effort:

- Central and West Basin Municipal Water Districts (CWBMWD);
- City of Los Angeles;

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- City of San Diego;
- The Metropolitan Water District of Southern California (MWD);
- San Diego County Water Authority (SDCWA);
- Santa Ana Watershed Project Authority (SAWPA); and
- South Orange County Reclamation Authority (SOCRA).

Major Objectives to Be Accomplished During the Study:

1) Identification and planning of implementation strategies for regional and area-wide water reclamation projects;
2) Identification and planning of groundwater recharge and storage projects with reclaimed water;
3) Identification and planning of environmental enhancement projects;
4) Identification and planning of institutional, financial, regulatory, and public acceptance measures to enhance the feasibility of water reuse; and
5) Development and implementation of a public involvement plan.

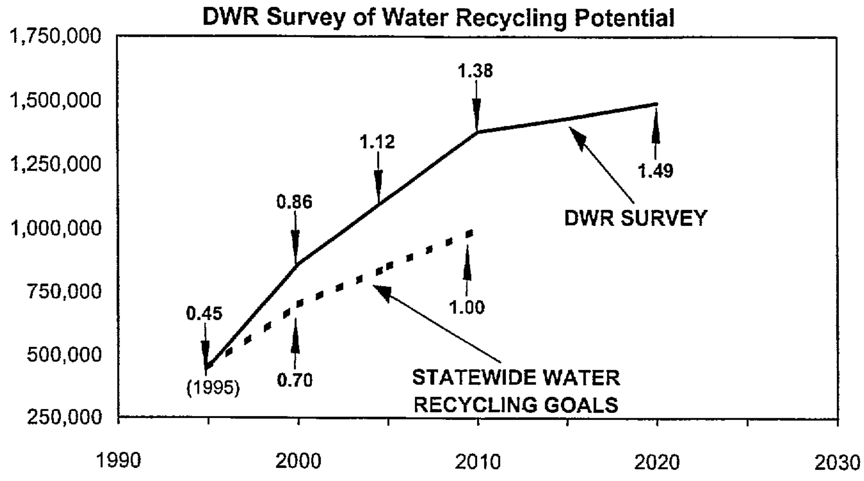
Two planning horizons will be used to examine the feasibility of future regional and area-wide water reclamation systems. A short-term horizon (year 2010) will be used to evaluate reclamation projects that could be implemented in the next decade. A second planning horizon of 50 years (year 2040) will be used to identify projects that may be feasible when implemented in the long-term.

1.9 WATER RECYCLING IN THE FUTURE

Existing water recycling projects provide more than 450,000 acre-feet of water each year for beneficial use in a variety of municipal, industrial, agricultural, and environmental applications. The Legislature adopted goals for the beneficial use of recycled water in 1991. The aim is to beneficially reuse 700,000 acre-feet of water per year by the year 2000 and 1 million acre-feet of recycled water by the year 2010. [4] A recent survey by the DWR identifies the potential for an additional 1 million acre-feet of recycled water use by the year 2020. As shown in Figure 1-1, the year 2020 water recycling potential is nearly 1.5 million acre-feet.

[4] Water Recycling Act of 1991, Cal Water Code § 13577.

FIGURE 1-1
STATEWIDE WATER RECYCLING POTENTIAL



1.10 LOCAL PROGRAMS THAT PROMOTE WATER RECYCLING

Most recycled water project development in California occurs on a local level. In some regions, larger water wholesaling agencies through "local projects programs" provide a financial contribution for each new acre-foot of water developed by its member agencies. These local project programs have had excellent success encouraging water recycling programs.

1.10.1 Local Resources Program of MWD:

For more than 15 years, MWD has actively supported water recycling and groundwater recovery projects that reduce Southern California's dependence on imported supplies. Through the Local Projects Program (LPP) and Groundwater Recovery Program (GRP), MWD provides funding for projects that produce recycled water for everything from toilet flushing in high-rise office buildings to landscape irrigation and recovered groundwater for municipal and domestic uses.

There are presently 43 water recycling and 11 groundwater treatment projects participating in MWD's LPP and GRP with and ultimate production of more than 230,000 acre-feet per year. As of July 1998, MWD has provided more than $54 million for the production of about 340,000 acre-feet of water.

In June 1998, the LPP and GRP were phased out and replaced by MWD's new competitive Local Resources Program (LRP). The LRP provides financial incentives up to $250 per acre-foot over terms up to 25 years to locally owned projects. MWD issued a Request for Proposals (RFP) for the development of 53,000 acre-feet per year of new water recycling and groundwater recovery projects that help achieve regional water supply reliability. Proposals will be evaluated by a review committee based on a set of regional ranking factors including readiness to proceed, project benefits and costs. MWD anticipates issuing similar competitive RFPs every two years.

1.10.2 Santa Clara Valley Water District

Santa Clara Valley Water District (SCVWD) has a similar financial incentive/rebate for recycled water projects. The SCVWD incentive payment of $115 per acre-foot has been incorporated into funding agreements with the cities of Sunnyvale and Santa Clara. In July 1997, the SCVWD Board of Directors revised its policy on water recycling and provided financial support on a project-specific basis. Funding is based upon key considerations:

- Financial need of the local project sponsor;
- Value of water supplied;
- Amount of recycled water produced (a portion of SCVWD funding could be up-front capital contribution); and
- Submission of a completed facility plan.

1.10.3 San Diego County Water Authority Reclaimed Water Development Fund (RWDF)

The San Diego County Water Authority (SDCWA) provides an incentive in its service area of up to $100 per acre-foot to those recycling projects that have a demonstrated financial need. Eligibility criteria are similar to that of the LPP of MWD, but the RWDF also takes the revenue side of the project into account. SDCWA defines a financial need as when the cumulative expenditures of a project exceeds its revenues. A project can receive the incentive for up to 25 years or until the point the project breaks even and recoups its cumulative costs. SDCWA currently has eight (8) contracts totaling 26,000 acre-feet per year. The program expects to contract with an additional five projects to bring the total program to approximately 45,000 acre-feet per year. The RWDF is seen as a supplement to the LPP/LRP of MWD and provides projects with a greater opportunity for covering costs in the early years of project start up.

1.11 THE ROLE OF THE GUIDEBOOK IN ANALYZING THE POTENTIAL FOR PROJECT DEVELOPMENT

1.11.1 Comprehensive Planning

Urban water agencies serving in excess of 3,000 customers or more than 3,000 acre-feet per year for municipal and industrial purposes, are required to prepare an Urban Water Management Plan (UWMP). The UWMP should include information on recycled water and its potential for use as a new water source in the service area of the urban water supplier. Local agencies subject to the UWMP Act are required to submit plans to the DWR every five years. The next submittal is due December 31, 2000.

In addition, most urban water agencies prepare a comprehensive water resource plan, commonly called an Integrated Resources Plan (IRP) or an Integrated Water Plan (IWP). The DWR updates the California Water Plan about every five years through the Bulletin 160 publications. Statewide and regionally, these comprehensive water resource planning processes provide a framework for evaluating water recycling feasibility.

It is the intent of the Guidebook to assist in providing a uniform, verifiable, locally directed process for water recycling feasibility assessments.

1.11.2 Technical Planning Assistance

Technical and planning assistance is critical to the successful achievement of feasible water recycling plans, and ultimately, projects. CUWA and the WateReuse Association have developed this Guidebook describing methods for the evaluation of water recycling projects. The

Guidebook and related technical assistance from CUWA and WateReuse will help local agencies carry out the engineering, economic, financial, and environmental impact evaluations that can lead to successful project implementation on the local level. It will also highlight the information needed to obtain any necessary permits or action from regulatory agencies.

In addition, the role of the Guidebook is to assist agencies with the preparation of the planning and feasibility studies required by state and federal funding agencies.

1.11.3 Funding Assistance

Recycled water projects typically consist of treatment facilities and pipeline distribution systems that require a significant capital investment. The DWR, SWRCB, and USBR (through Title XVI, PL 102-575) have financing programs for the purpose of funding treatment plants and distribution facilities.

The three basic funding mechanisms in California for a local sponsor of a water recycling project are as follows:

- Regional agency funding (LPP of MWD, Local Resources Program of SDCWA, and financial assistance program of Santa Clara Valley Water District);
- SWRCB Water Recycling Loan Program and State Revolving Fund (Proposition 204 funding of water recycling -- $60 million); and
- USBR Title XVI funding (25 percent of construction costs of an authorized project up to $20 million).

However, each of these funding mechanisms requires different types and levels of documentation and reports to be submitted for review and approval. Local agencies seeking funding for more than one of these mechanisms might find the process very difficult, repetitive, and time consuming. Therefore, it is suggested that uniform guidelines be developed to streamline the funding process.

It is hoped that the Guidebook will provide a model for uniform guidelines and reporting requirements for water recycling projects among various funding agencies.

1.12 KEY REFERENCES AND AGENCY CONTACTS

Statewide Water Planning Resources

1) WateReuse Association Web Page serves as a comprehensive reference and contact source - www.WateReuse.org.
2) California Department of Water Resources, Division of Planning and Local Assistance, Office of Water Recycling Assistance - 916/327-1666. (www.dwr.water.ca.gov).
3) CALFED Bay-Delta Program, 1416 Ninth Street, Suite 1155, Sacramento, CA 98514; 916/657-2666; Fax 916/654-9780; Web Page (http://calfed.ca.gov/).
4) Water Education Foundation, "Layperson's Guides to Water Recycling,"717 K Street, Suite 517, Sacramento, CA 95814; 916/444-6240.
5) Pacific Institute - *California Water 2020, A Substantial Vision,* Dr. Peter Gleick, 916/2274580.
6) SWRCB Office of Water Recycling 916/227-4580.
7) USBR Title XVI Guidelines – (Sacramento) 916/978-5060 or Temecula 909/978-5060.
8) Metropolitan Water District of Southern California – Planning and Resources Division, Local Resources Program – 213/217-6230 (www.MWD.gov).
9) Peter MacLaggan, "Water Reclamation: A Summary of California Law and Regulation," 1995 Edition. Argent and Shuster Publishing (916/367-3844).

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Section 2

STEPS IN THE PROCESS OF DETERMINING FEASIBILITY

This section focuses on the steps in the planning processes that determine project feasibility of a water recycling project or program. It outlines the elements generally included in the preparation of a Water Recycling Concept Planning Report and subsequently in a Water Recycling Feasibility Report. The typical steps and timeframe to complete in the planning and development of a water recycling project are shown on Table 2-1.

TABLE 2-1
SUMMARY OF KEY PROJECT IMPLEMENTATION ACTIVITIES

Activity Area	Key Activities	Critical Path Issues
PLANNING (6 to 36 Months)	▪ Concept Planning to Master Plan ▪ Detailed Feasibility Studies ▪ Market Analysis ▪ DOHS and RWQCB Coordination ▪ Feasibility Report ▪ CEQA/NEPA Compliance Studies and Documentation for Program ▪ Financial Plan ▪ DWR/SWRCB Loan Applications ▪ USBR Title XVI Funding ▪ Regional Watershed Studies Coordination ▪ Coordination with Other Agencies/ Public Outreach Coordination Involvement	▪ Develop Priority List of Water Recycling Projects ▪ CEQA/NEPA Compliance and Certification ▪ State/Federal Funding Application ▪ Congressional Authorization ▪ Interagency Coordination ▪ Local Funding Authorization
DESIGN (6 to 18 Months)	▪ Preliminary Design ▪ Potential Customers Verification ▪ Permitting Activities ▪ Finance Plan, Budget and CIP ▪ Final Design ▪ Implementation Schedule (timing and size of facilities) ▪ Public Outreach	▪ Interagency Agreements ▪ State/Federal Funding Approval ▪ Issue Revenue Bonds (or COPs) ▪ Regulatory Permits
CONSTRUCTION (1 to 5 Years)	▪ Construction Plans ▪ Management Plan ▪ Action Plan ▪ Bid Packages and Solicit Bids ▪ Community Relations/Public Outreach	▪ Capital Funds in the Bank ▪ Construction Management Activities ▪ Federal Reimbursement (quarterly based upon actual expenditures)
OPERATIONS	▪ Staffing Plan ▪ Permitting Conditions and Monitoring ▪ Customer Service and Coordination	▪ Project Startup and Permitting Reports ▪ Quality Assurance of Supply to Customers ▪ RWQCB Permit Compliance Activities

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From an overall perspective, water recycling is just one component of a comprehensive water management strategy. Comprehensive water resource planning is not a new idea and historically has been incorporated into long-term Master Plans for system development. However, urban water agencies have recently adopted the term, Integrated Resource Planning (IRP) from the electric utility industry.

> **"Integrated resource planning is a comprehensive form of planning that encompasses least-cost analysis, including demand-side and supply-side management options, an open and participatory decision making process, and consideration of the multiple institutions concerned with water policy."**
>
> **("American Waterworks Association Whitepaper," 1995)**

Water recycling is one water supply option that should be evaluated with other traditional water supplies (i.e., local groundwater, additional imported supplies, surface reservoirs, water conservation, and water transfers) to develop an overall comprehensive integrated water resource strategy. In addition, since "least-cost planning" for water resources typically looks at all water related infrastructure requirements, IRP planning should examine wastewater requirements to identify the opportunities to recycle water that avoid expensive new capital improvements.

2.1 THE INTEGRATED RESOURCE PLAN (IRP)

A COMPREHENSIVE METHODOLOGY FOR COMPARING COSTS AND OTHER FACTORS OF WATER SUPPLY OPTIONS

Water resource agencies throughout the United States are using integrated water resource planning processes to develop flexible, long term water supply plans that meet the needs of the agencies and communities they serve. Key elements of IRP planning are community outreach and involvement and flexibility to respond to changing water supply conditions.

The basic work of the IRP is to develop several alternative water resource strategies and rate them against planning objectives that are determined based on local needs with the goal of selecting a final preferred strategy. The alternative strategies consist of key components which are defined as water supply or demand management options. The key components of any IRP prepared in California are:

- Demand Management (water conservation),
- Water Recycling.
- Groundwater Conjunctive Use (local or outside service area),
- New surface reservoir,
- Long term or dry year water transfers, and
- Desalination of brackish water or seawater.

These components, when used together, create water supply strategies to meet the projected future demands.

Planning objectives typically include categories to evaluate operational, risk, economic, community, and environmental criteria. The preferred strategy is that water supply strategy which best satisfies the greatest number of planning objectives.

2.2 URBAN WATER MANAGEMENT PLANNING ACT

All urban water suppliers with over 3,000 customers are required every five years (e.g., 1990, 1995, 2000) to file an adopted Urban Water Management Plan (see Water Code Sections 10610-10656 for requirements) with the Department of Water Resources (DWR). UWMPs contribute to the IRP process by providing important local information on potential water supplies and efficient water uses. The IRP process utilizes such data to establish the "Preferred Resource Mix" which balances the use of local water resources, imported supplies, and demand-side management investments to achieve water supply reliability in a cost-effective manner.

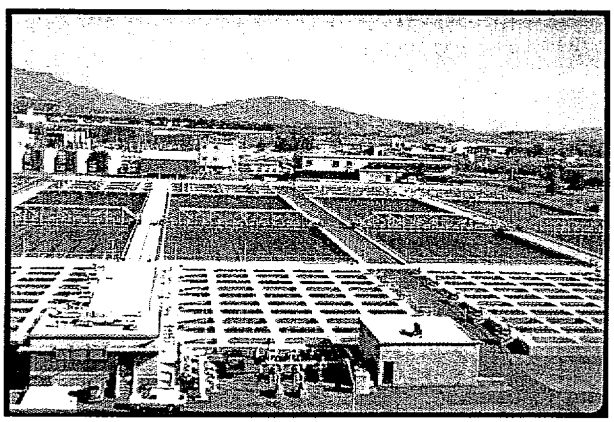
In 1995, the legislature amended the UWMP Act requirements to include a Recycled Water Element in the 1995 UWMPs. Below is a summary of the water recycling elements of the UWMP:

- Provide information on recycled water and its potential for use as a water source in the service area of the urban water supplier;
- Describe the wastewater collection and treatment systems in the supplier's service area, including a quantification of the amount of wastewater collected and treated and the methods of wastewater disposal;

- Note the recycled water currently being used in the supplier's service area, including, but not limited to the type, place, and quantity of use;
- Determine and quantify the technical and economic feasibility of the potential uses of recycled water, including, but not limited to: agricultural irrigation, landscape irrigation, wildlife habitat enhancement, wetlands, industrial reuse, groundwater recharge, and other appropriate uses;
- Identify the projected uses of recycled water within the supplier's service area at the end of 5, 10, 15, and 20 years;
- Provide a description of actions, including financial incentives, which may be taken to encourage the use of recycled water where fresh water is not necessary. Include the projected results of these actions in terms of acre-feet of recycled water used per year;
- Prepare a plan for optimizing the use of recycled water in the supplier's service area, including actions to facilitate the installation of dual distribution systems and to promote recycling uses;
- Include a schedule of proposed implementation and steps necessary to implement proposed actions; and
- Coordinate the preparation of the plan with local water, wastewater, and planning agencies.

2.3 WATER RECYCLING FEASIBILITY REPORT

If an IRP or UWMP indicates that recycling should be a part of the urban agency's water supply program, the next step is to prepare a conceptual plan on the potential for water recycling. Conceptual planning defines the potential project, estimates capital and operating costs and identifies potential markets. Although the terminology varies, a concept planning report for a water recycling program (federal agencies commonly describe this initial planning report as an appraisal level investigation) is generally prepared by agency staff or their consultant. Sometimes the concept planning may be accomplished in the IRT or UWMP process.



Based upon positive results of the concept-level planning report, the next step is to prepare a feasibility report. This report would include a more detailed investigation of the project, including: physical features, associated engineering costs, water rights issues, water quality considerations, market surveys, economic and financial analyses and budgets, as well as a detailed implementation schedule. Typically, environmental documentation requirements to meet the California

Environmental Quality Act (CEQA) and possibly the National Environmental Policy Act (NEPA) would be completed along with the feasibility report. The budget for a feasibility report is generally in the range of $100,000 to $500,000, depending on the size and complexity of the water recycling program. CEQA/NEPA compliance would be an additional cost and is approximately in the same budget range. An outline for a typical feasibility report is shown in Table 2-2.

D R A F T

TABLE 2-2
FEASIBILITY/PLANNING STUDY
Report Outline

Executive Summary
Chapter 1 Introduction
Chapter 2 Description of Study Area 2.1 General 2.2 Population, Land Use and Water Demand 2.3 Local Water & Wastewater Agencies
Chapter 3 Wastewater Treatment Facilities 3.1 Available Flow 3.2 Water Quality Considerations 3.3 Additional Facilities for Water Reclamation
Chapter 4 Recycled Water Markets and Distribution Criteria 4.1 Identification of Markets 4.1.1 Identification of Market Types 4.1.1.1 Irrigation Uses 4.1.1.2 Industrial/Commercial Uses 4.1.1.3 Environmental Uses 4.1.1.4 Groundwater Recharge 4.1.2 Market Research Methodology 4.1.3 Description of Findings 4.2 Water Quality Requirements for Markets 4.3 Recycled Water Market Assessment

TABLE 2-2 (Continued)
FEASIBILITY/PLANNING STUDY
Report Outline

Chapter 5 Distribution and Storage Design Criteria 5.1 Demand Variations 5.2 Peaking Factors 5.3 Recycled Water Distribution System Criteria
Chapter 6 Recycled Water Storage and Distribution Facilities
Chapter 7 Alternative Analysis
Chapter 8 Project Costs 8.1 Construction Costs 8.2 Engineering, Project Administration Costs, and Construction Services 8.3 Annual Operational and Maintenance Costs 8.4 Summary of Cost 8.5 Other Monetary and Non-Monetary Considerations 8.6 Economic Analysis 8.6.1 Analysis of Water Reclamation Alternatives 8.6.2 No-Project Alternative 8.6.3 Summary of Economic Analysis
Chapter 9 Water Reclamation Phasing Plan 9.1 Identification of Service Areas 9.2 Development of Recommended Project Phasing Plan
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2.3.1 Identification of Sources of Supply

The potential sources of a recycled water supply should be identified early in the planning process. In many cases, an existing tertiary wastewater reclamation plant complying with Title 22 regulation will be the primary supplier of recycled water. Upgrading other wastewater plants with additional treatment to meet Title 22 (or other customer water quality requirements) may also be a source of recycled water. Another source of supply may be local wells that are high in nitrates (and not generally suitable for drinking water) that can be used to provide a supplemental supply.

2.3.2 Know Your State and Local Health Requirements

A section of the Feasibility Report should be focused on identifying public health requirements and permitting issues. The production and use of reclaimed water is carefully controlled through state laws and administrative regulations. The California Department of Health Services (DHS) is responsible for the adoption of regulations for the use of reclaimed water. The Regional Water Boards issue reclamation requirements for individual water reclamation projects in conformance with regulations adopted by the DHS. Requirements for a use of reclaimed water not addressed by the uniform statewide criteria are established by the DHS on a case-by-case basis (i.e., groundwater recharge).

The DHS establishes water quality standards and treatment reliability criteria for recycled water operations in Title 22, Chapter 4, of the California Code of Regulations. The intent of the Title 22 regulations is to establish uniform statewide reclamation criteria in order to ensure that the use of recycled water for the specified purposes does not impose undue risks to health. The regulations set forth acceptable levels of constituents of recycled water and prescribe methodology for assuring reliability in the production of reclaimed water. The Legislature intended the Title 22 criteria to apply uniformly throughout the state.

Public health officers are generally precluded from placing additional public health requirements on water recycling projects.

The existing Title 22 reclamation criteria were adopted by the DHS in 1977. Since that time, the use of reclaimed water has greatly expanded and water treatment technology achieved considerable advances. The DHS has developed proposed revisions to the Title 22 reclamation criteria. The revisions are intended to expand the range of allowable uses of reclaimed water and clarify the existing requirements. Most, if not all, of these applications are already being permitted on a case-by-case basis today.

Title 22 establishes bacteriological water quality standards on the basis of the expected degree of public contact with reclaimed water. For water reuse applications with a high potential for the public to come in contact with the reclaimed water, Title 22 requires disinfected tertiary treatment ("unrestricted use quality"). For applications with a lower potential for public contact, Title 22 requires three levels of secondary treatment.

DHS has created a strong incentive for the recycled water suppliers to provide unrestricted use quality water for all of its recycled water customers. First, the market for lower quality recycled water is greatly restricted. Second, unrestricted use quality water is presumed to be pathogen free. This is a very important consideration when it comes to maximizing public acceptance and minimizing supplier's exposure to liability.

Title 17, also pending revision, establishes cross-connection control requirements for recycled water use areas. There are capital costs and ongoing maintenance costs associated with Title 17 requirements which need to be taken into consideration in the market assessment and development of alternatives.

Since the proposed revisions to Title 22 and Title 17 regulations are still pending adoption, there remains some uncertainty as to exactly how DHS will regulate the use of recycled water in the future. However, the rule making process has nearly run its course and for the most part, the draft regulations are non-controversial.

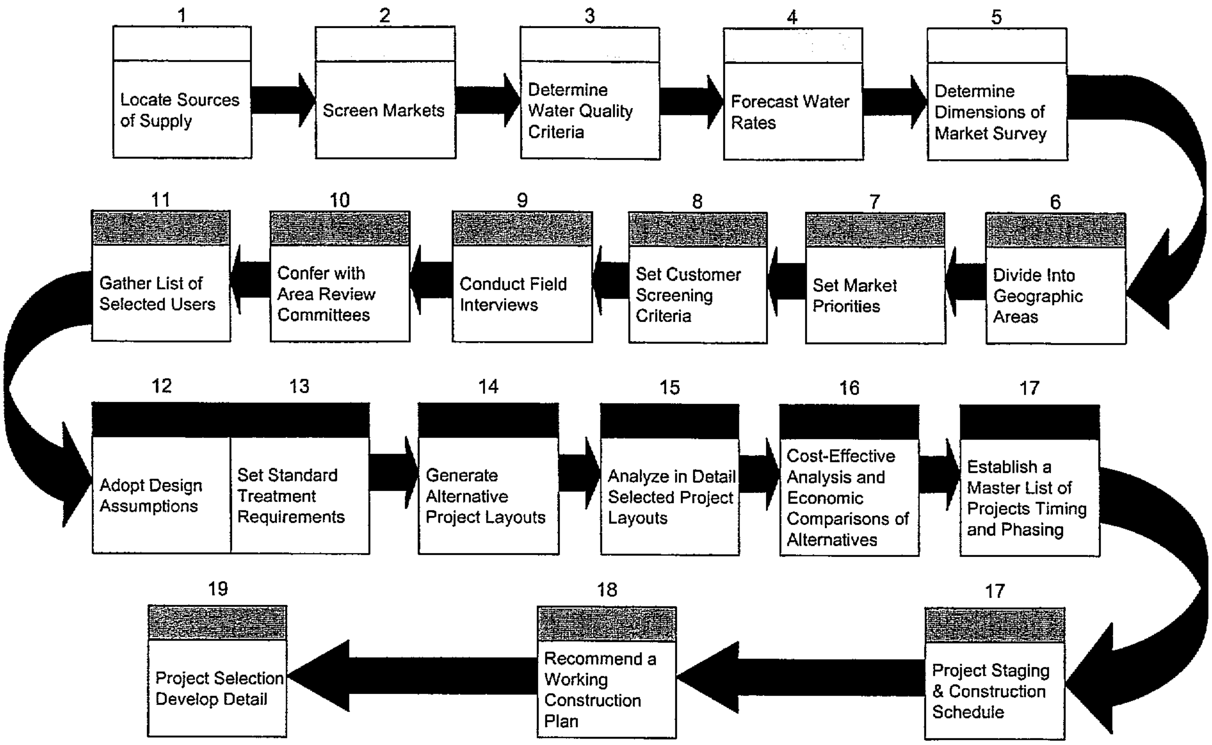
2.3.3 Water Rights Issues

The California Water Code states that the owner of the wastewater treatment plant has a superior right to the recycled water over anyone who has discharged water into the wastewater collection system, unless there is an agreement to the contrary. The ability to recover the recycled water supply becomes a bit more complex, once it has been discharged to an inland stream. No comprehensive state law governs storage rights in an unadjudicated groundwater basin. Generally, public agencies may store and recapture recycled water within certain limits. In establishing the feasibility of the recycled water project, proponents will need to evaluate various ways in which these circumstances may arise and assess the rights of the parties involved.

The Water Code also provides that an existing water right shall not lapse, be lost, or reduced where recycled water is used in lieu of appropriated water. Water that has been conserved as the result of the use of the recycled water may be sold, leased, exchanged or otherwise transferred by the water rights holder pursuant to any provision of law relating to the transfer of water.

Another key legal issue with developing recycled water projects is the retail purveyorship issue. Under the California Public Utilities Code (Section 1500-1507) and the Water Code (Sections 31053 and 31054) both public and private water utilities are protected from "loss of value: of water facilities stranded from service duplication with recycled water. Generally, it is recommended that recycled water should be retailed to the customer by the existing utility serving that customer to avoid this issue.

Figure 2-1
Water Recycling Market Assessment Process



(from OLAC Water Reuse Study, Volume 1)

2.3.4 Recycled Water Market Assessment

It is important to gain an accurate assessment of the number and types of potential users and their water quality and quantity needs. The most common markets in urban areas are irrigation of landscaping in parks, playgrounds, schools, golf courses, nurseries, and street medians or for industrial process and cooling water. In addition, the market may include the potential for agricultural irrigation, groundwater recharge, stream augmentation or recreational lakes. Although some potential users will be obvious by examining aerial photographs (i.e., large green areas), there may be many smaller users that are more difficult to identify or evaluate. The first place to look is in water purveyor records to identify every water customer using over a minimum quantity of water per year (10-acre feet, for example). In addition to analyzing water utility billing records, the market assessment may include:

- Analysis of aerial photographs or maps to identify large irrigated areas;
- Questionnaires mailed to school districts, park departments, superintendents and public works directors;
- Presentations (using videos and other educational materials) made to community groups, such as the chamber of commerce, where representatives of industrial or commercial ventures will be present; and
- Presentation to industry organizations and associations.

Surveys can then be sent to potential users asking for information on how much water is used for landscape irrigation, cooling, process water, etc. Based on the results of the survey, each potential customer for recycled water must be interviewed by phone or in person.

The purpose of the survey and interview is to educate the potential customer on the possible benefits of using recycled water and to determine the details of their uses, including desired quantities, rates of delivery, quality considerations and the degree of difficulty in retrofitting for recycled water use on the premises. It is also important to evaluate the likelihood that the proposed use will remain for 20 years or more or whether there are factors which might cause the business to close or the green area to be converted into housing. Planning should not be based on overly optimistic assessments. The results of the survey will be summarized in reports, tables, maps, and a computerized database used in the development of a conceptual recycled water production and pipeline distribution plan. Generally, the potential users are divided into two categories:

- Users large enough to justify the construction of a pipeline to them (greater than 10 acre-feet per year, for example), and
- Users that would only be served if the distribution pipeline passed nearby (less than 10 acre-feet per year).

Before initiating a marketing program, an agency needs to assess its capability of providing service to each type of potential user. The agency should have the resources to sustain a long-term service commitment to each type of user selected for marketing. Those resources can include personnel training, an adequate number of service representatives, and an in-depth understanding of the users specific technical processes and water quality needs.

2.4 WATER QUALITY REQUIREMENTS

Although there are numerous generic listings of water quality requirements for various types of irrigation and industrial purposes, each proposed use must be analyzed carefully. The chemical characteristics of the current potable supply should be compared to those of the proposed recycled water. Sometimes pilot testing of the potential recycled water supply on the proposed process or soil is required to assure that the changes in water quality will not affect growth, production, volume used, or costs of operation.

2.4.1 Irrigating Crops and Landscaping

Water quality requirements for irrigation customers depend upon the type of soil, specific crop or landscaping being irrigated, and degree of public access. Public access and whether the edible portion of the crop is directly exposed to the recycled water determine the required degree of treatment and disinfection. The chemical composition and salinity of the recycled water is critical for the successful long term use of recycled water. A summary of critical constituents for irrigation projects is included in Tables 2-3 and 2-4 (from *Irrigation with Reclaimed Municipal Wastewater-A Guidance Manual* by Pettygrove & Asano) and a listing of salt tolerances for various types of crops is listed in Table 2-5. Determination of soil types and permeability is essential to the analysis. Each irrigation site should be carefully evaluated by a competent agronomist to establish compatibility between the intended use and the chemical quality of the available source of recycled water.

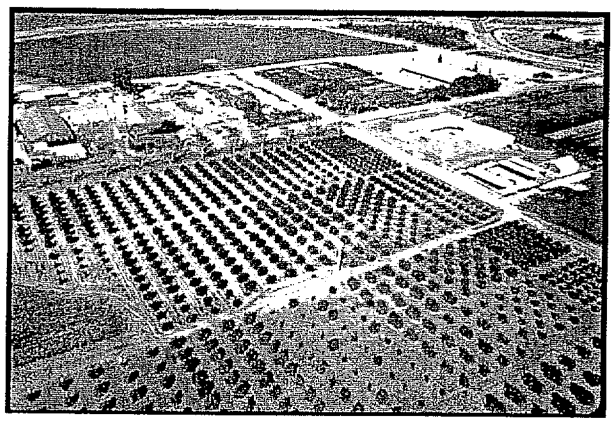


TABLE 2-3
GUIDELINES FOR INTERPRETATION OF WATER QUALITY FOR IRRIGATION [1]

Potential Irrigation Problems	Units	Degree of Restriction on Use		
		None	Slight to Moderate	Severe
Salinity (affects crop water availability)				
EC_w[b]	dS/m or mnho/cm	<0.7	0.7-3.0	>3.0
TDS	Mg/L	<450	450-2000	>2000
Permeability (affects infiltration rate of water into the soil. Evaluate using EC_w and SAR together) [3,4]				
SAR = 0 - 3	And EC_w	= >0.7	0.7-0.2	<0.2
= 3 - 6		= >1.2	1.2-0.3	<0.3
= 6 - 12		= >1.9	1.9-0.5	<0.5
= 12 - 20		= >2.9	2.9-1.3	<1.3
= 20 - 40		= >5.0	5.0-2.9	<2.9
Specific ion toxicity (affects sensitive crops)				
Sodium (Na) [5,6]				
Surface irrigation	SAR	<3	3-9	>9
Sprinkler irrigation	Mg/L	<70	>70	
Chloride (Cl) [5,6]				
Surface irrigation	Mg/L	<140	140-350	>350
Sprinkler irrigation	Mg/L	<100	>100	
Boron (B)	Mg/L	<0.7	0.7-3.0	>3.0
Trace elements (see Table 3-5)				
Miscellaneous effects (affects susceptible crops)				
Nitrogen (total-N) [7]	Mg/L	<5	5-30	>30
Bicarbonate (HCO_3) (overhead sprinkling only)	Mg/L	<	90-500	>500
PH			Normal range 6.5-8.4	
Residual chlorine (overhead sprinkling only)	Mg/L	<1.0	1.0-5.0	>5.0

1 Adapted from University of California Committee of Consultants [7] and Ayers and Westcot [8]. The basic assumptions of the guidelines are discussed on the second page of this table.

2 EC_w means electrical conductivity of the irrigation water, reported in mmho/cm or dS/m. TDS means total dissolved solids, reported in mg/L.

3 SAR means sodium adsorption ratio. SAR is sometimes reported as R_{Na}. At a given SAR, infiltration rate increases as salinity (EC_w) increases. Evaluate the potential permeability problems by SAR and EC_w in combination. Adapted from Rhoades [9] and Oster and Shroer [10]

4 For wastewater, it is recommended that SAR be adjusted to include a more correct estimate of calcium in the soil water following and irrigation. The adjusted sodium adsorption ratio (adj R_{Na}) calculated by the is procedure is to be substituted for the SAR value.

5 Most tree crops and woody ornamentals are sensitive to sodium and chloride; use the values shown. Most annual crops are not sensitive; use the salinity tolerance tables.

6 With over head sprinkler irrigation and low humidity (<30%), sodium or chloride greater than 70 or 100 mg/L, respectively, have resulted in excessive leaf absorption and crop damage to sensitive crops.

7 Total nitrogen should include nitrate-nitrogen, ammonia-nitrogen, and organic-nitrogen. Although forms of nitrogen in wastewater vary, the plant responds to the total nitrogen.

Table 2-3
Continued

Guideline Assumptions

The water quality guidelines in Table 3-4 are intended to cover the wide range of conditions encountered in California's irrigated agriculture. Several basic assumptions have been used to define the range of usability for these guidelines. If the water is used under greatly different conditions, the guidelines may need to be adjusted.

Wide deviations from the assumptions might result in incorrect judgments on the usability of a particular water supply, especially if it is a borderline case. Where sufficient experience, field trials, research or observation are available, the guidelines may be modified to more closely fit local conditions.

The basic assumptions in the guidelines are given below:

- **Yield Potential:** Full production capability of all crops, without the use of special practices, is assumed when the guidelines indicate no restrictions on use. A "restriction on use" indicates that there may be a limitation, such as choice of crop or need for special management in order to maintain full production capability. However, a "restriction on use" does **not** indicate that the water is unsuitable for use.
- **Site Conditions:** Soil texture ranges from sandy-loam to clay with good internal drainage. Rainfall is low and does not play a significant role in meeting crop water demand or leaching. In the Sierra and extreme North Coast areas of California where precipitation is high for part or all of the year, the guideline restrictions are too severe. Drainage is assumed to be good with no uncontrolled shallow water table present.
- **Methods and Timing of Irrigation:** Normal surfaces and sprinkler irrigation methods are used. Water is applied infrequently as needed, and the crop utilizes a considerable portion of the available stored soil water (50% or more) before the next irrigation. At least 15% of the applied water percolates below the root zone (leaching fraction [LF] > 15%). The guidelines are too restrictive for specialized irrigation methods, such as drip irrigation, which result in near daily or frequent irrigation. The guidelines are not applicable for subsurface irrigation.
- **Water Uptake by Crops:** Different crops have different water uptake patterns. However, all crops take water from wherever if is most readily available within the root zone and maintain it at a relatively low salinity. Salinity increases with depth and is greatest in the lower part of the root zone. The average salinity of the soil solution is about three times that of the applied water.

  Salts leached from the upper root zone accumulate to some extent in the lower part but eventually are moved below the root zone by sufficient leaching. The crop responds to average salinity of the root zone. Higher salinity in the lower root zone becomes less important, if adequate moisture is maintained in the upper, "more active" part of the root zone.

TABLE 2-4
RECOMMENDED MAXIMUM CONCENTRATION OF TRACE ELEMENTS IN IRRIGATION WATERS [1]

Element	Recommended maximum concentration [2] (mg/L)	Remarks
Al (aluminum)	5.0	Can cause non-productivity in acid soils (pH < 5.5), but more alkaline soils at pH ≥ 5.5 will precipitate the ion and eliminate any toxicity.
As (arsenic)	0.10	Toxicity to plants varies widely, ranging from 12 mg/L for Sudan grass to less than 0.05 mg/L for rice.
Be (beryllium)	0.10	Toxicity to plants varies widely, ranging from 5 mg/L for kale to 0.5 mg/L for bush beans.
Cd (cadmium)	0.01	Toxic to beans, beets, turnips at concentrations as low as 0.1 mg/L in nutrient solutions. Conservative limits recommended because of its potential for accumulation in plants and soils to concentrations that may be harmful to humans.
Co (cobalt)	0.05	Toxic to tomato plants at 0.1 mg/L in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Cr (chromium)	0.1	Not generally recognized as an essential growth element. Conservative limits recommended because of lack of knowledge on toxicity to plants.
Cu (copper)	0.2	Toxic to number of plants at 0.1 to 1.0 mg/L in nutrient solutions.
F (fluoride)	1.0	Inactivated by neutral and alkaline soils.
Fe (iron)	5.0	Not toxic to plants in aerated soils, but can contribute to soil acidification and loss of reduced availability of essential phosphorus and molybdenum. Overhead sprinkling may result in unsightly deposits on plants, equipment and buildings.
Li (lithium)	2.5	Tolerated by most crops up to 5mg/L; mobile in soil. Toxic to citrus at low levels (>0.075 mg/L). Acts similar to boron.
Mn (manganese)	0.2	Toxic to a number of corps at a few tenths mg to a few mg/L, but usually only in acid soils.
Mo (molybdenum)	0.01	Not toxic to plants at normal concentrations in soil and water. Can be toxic to livestock if forage is grown in soils with high levels of available molybdenum.
Ni (nickel)	0.2	Toxic to a number of plants at 0.5 to 1.0 mg/L; reduced toxicity at neutral or alkaline pH.
Pb (lead)	5.0	Can inhibit plant cell growth at very high concentrations.
Se (selenium)	0.02	Toxic to plants at concentrations as low as 0.025 mg/L and toxic to livestock if forage is grown in soils with relatively high levels of added selenium. An essential element for animals but in very low concentrations.
Sn (tin)	—	Effectively excluded by plants; specific tolerance unknown.
Ti (titanium)	—	(See remark for tin)
W (tungsten)	—	(See remark for tin)
V (vanadium)	0.1	Toxic to many plants at relatively low concentrations.
Zn (zinc)	2.0	Toxic to many plants at widely varying concentrations; reduced toxicity at pH >6.0 and in fine textured or organic soils.

1 Adapted from Water Quality Criteria [11] and Pratt [12].

2 The maximum concentration is based on a water application rate that is consistent with good agricultural practices (4 acre-ft/acre-year). If the water application rate exceeds this, the maximum concentration should be adjusted downward accordingly. No adjustment should be made for application rates of less than 4 acre-ft per year per acre. The values given are for waters used on a continuous basis at one site for the irrigation supply water.

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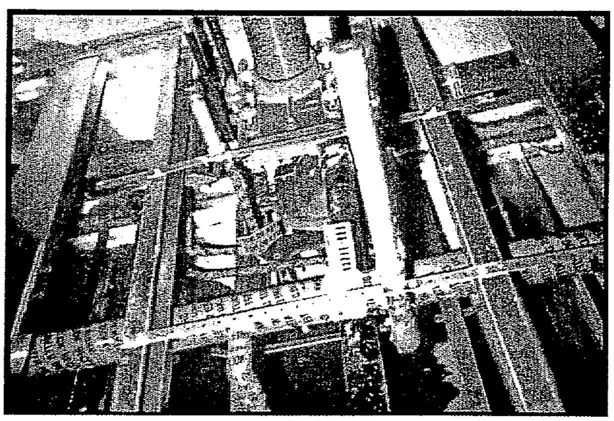
TABLE 2-5
IRRIGATION WATER SALT TOLERANCES FOR SELECTED CROPS [1,2,3,4]

Crop	Irrigation Water TDS (mg/l)
Apples	725
Avocado	555
Citrus	768
Grapes	640
Macadamia	840
Persimmons	768
Strawberries	427
Roots, bulbs, tubers	640 - 2,560
Carnations [5]	640 - 1,280
Gladiolas	429 - 840
Poinsettias [5]	1,058 - 1,728
Roses	1,472
Beans	427
Corn	726
Cucumbers	1,087
Mushrooms	Highly Insensitive
Potatoes	725
Squash	853
Tomatoes	1,067
Fescue	1,864
Bermuda Grass	2,944

1 Data Sources: Western Fertilizer Handbook, San Diego Area Reuse Study; Strawberry News Bulletin; Knott's Vegetable Handbook; Soils: An Introduction to Soils & Plant Growth, 4th Edition, D.M.S., no dates.
2 Under normal conditions, soil moisture salinity (ECe) is approximately 1.5 x irrigation water salinity (ECw) or (ECe = 1.5 x ECw).
3 Under drought conditions, soil salinity can be as much as 3 x ECw.
4 Salinity tolerance levels assume no yield reductions.
5 Salinity levels assume 10 percent yield decrease.

2.4.2 Evaluating Needs of Commercial and Industrial Customers

Commercial and industrial water customers with high water demands must be evaluated on a case-by-case basis. The largest uses are generally for cooling system make-up water or process water for specific industries. Other uses include boiler feed water, washdown water, fire protection, and dust control. Most industrial or commercial process water uses already involve onsite treatment of the water with scale inhibitors or other chemicals to adjust the character of the water for its intended uses. General estimates of the applicability of a particular recycled water source to a specific industrial or commercial



use can be obtained by comparing chemical constituents of the recycled water with the values in Table 2-6 (Table 3.5 of the *Water Reuse Manual of Practice SM-3, Second Edition*, WEF, 1989) for cooling water and Table 2-7 (Table 3.6, same ref. as for Table 3.5) for selected industrial processes. A user friendly handbook on cooling towers has been prepared by WBMWD/CBMWD and MWD ("Handbook On The Use of Recycled Water for Industrial/Commercial Cooling Systems," 1993).

TABLE 2-6
Quality Requirements of Cooling Water Makeup Due to Re-circulation

Characteristic	Concentration mg/L
Silica (SiO_2)	50
Aluminum (Al)	0.1
Iron (Fe)	0.5
Manganese (Mn)	0.5
Calcium (Ca)	50
Ammonia (NH_3-N)	1.0
Bicarbonate (HCO_3)	24
Sulfate (SO_4)	200
Chloride (Cl)	500
Total Dissolved Solids	500
Hardness ($CaCO_3$)	650
Alkalinity ($CaCO_3$)	350
Methylene blue active substances	1
Chemical oxygen demand (COD)	75
Suspended Solids	100
Phosphorus (P)	1.0

TABLE 2-7
INDUSTRIAL PROCESS WATER QUALITY REQUIREMENTS

	Pulp and Paper					Textile Products		
Parameter	Mechanical Pulping	Chemical, unbleached	Pulp and Paper, Bleached	Chemical	Petro-Chemical and coal	Sizing Suspension	Scouring, bleaching, dying	Cement
Al [1]								
Cu						0.05	0.01	
Fe	0.3	1.0	0.14	0.1	1.0	0.3	0.1	2.5
Mn	0.1	0.5	0.05	0.1		0.05	0.01	0.5
Zn								
Ca		20	20	68	75			
Mg		12	12	19	30			
Cl	1000	20	200	500	300			250
NH_4								
HCO_3				128				
NO_3				5				
SO_4				100				
SiO_2		50	50	50				
Hardness		100	100	250	350	25	25	
Alkalinity				125				400
TDS				1000	1000	100	100	600
TSS		10	10	5	10	5	5	500
COD								
Color	30	30	10	20		5	5	
PH	6-10	6-10	6-10	6.2-8.3	6-9			6.5-8.5
CCE								1

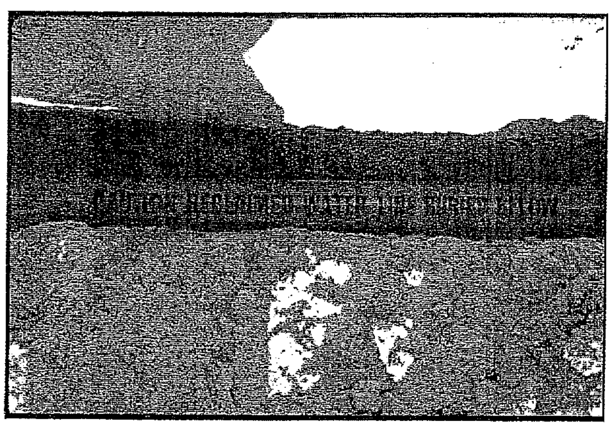
[1] All values are in mg/L except color and pH.

2.5 USER AGREEMENTS

Generally, the potential user of recycled water must complete and file an application with the local purveyor who is charged with administering the sale of the recycled water. The application specifies the user's water quality, quantity, and timing needs and commits the user to complying with applicable regulations governing its use on his property. When the use application has been reviewed and accepted by the purveyor, the purveyor will issue a user agreement, which is essentially a contract to provide recycled water service to the user. The Agreement describes the rights and responsibilities of both parties. The Agreement also becomes the user's permit to operate the recycled water system and spells out the required operating conditions. The purveyor commits to supplying water that meets the health department requirements for the specified use. The user is furnished with a standard user's manual which elaborates on the conditions and responsibilities. Sometimes user agreements provide for utility funding of on-site plumbing retrofit facilities and a repayment obligation by the customer.

2.6 NOTICING, COMPLIANCE AND PENALTY PROCEDURES

The purveyor reserves the right to inspect the user's facilities to verify compliance with the specified use conditions in the permit or user manual. However, users are also required to notify the purveyor of any violation of conditions of which they are aware. Violations may include failure to comply with permit conditions or applicable federal, state or local codes, ordinances, or other lawful conditions that regulate the use of recycled water. Violations can be as simple as accidentally letting irrigation overflow pass off of the property or as serious as having a cross-connection to the potable water system.



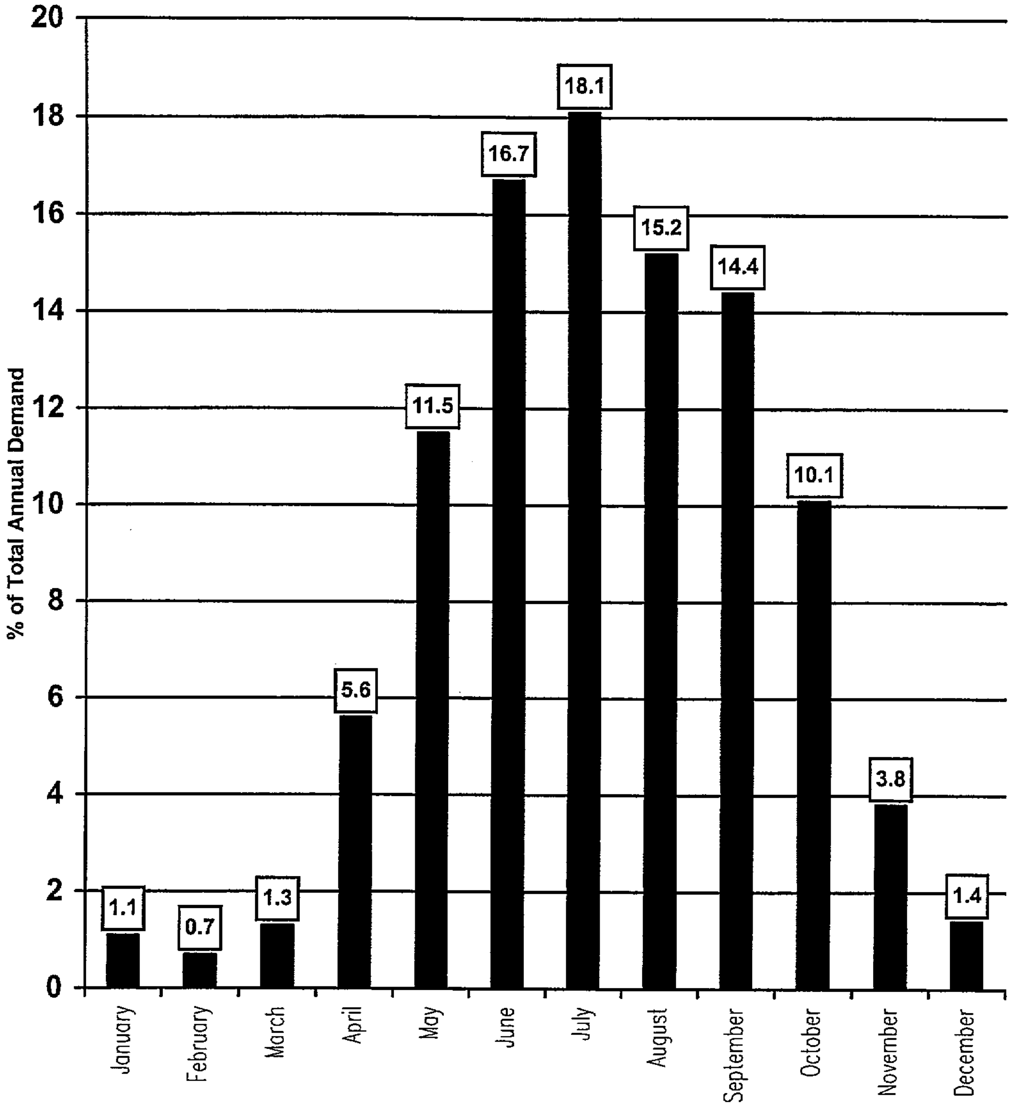
If the purveyor finds a violation, the user must be immediately notified and given an opportunity to take appropriate corrective action. Failure of the user to respond in a timely manner or the existence of a condition constituting an imminent health hazard will result in termination of recycled water service. Sometimes the purveyor will assess a startup fee after the problem has been corrected and before resumption of service. Certain types of violations may also result in penalties, as prescribed by the purveyor's ordinance or federal and/or state laws. Enforcement of regulations by the purveyor must be carried out impartially and there should be an appeal procedure built into the process. Usually the user can appeal to the Board of Directors of the public or private agency that serves as water purveyor.

2.7 IDENTIFY PEAKING REQUIREMENTS AND SIZE SYSTEM ACCORDINGLY

Feasibility reports should include identification of routes and sizing of distribution pipelines to serve the optimum combination of potential customers identified in the market assessment phase. Pipeline sizes and pumping requirements are dependent upon identifying applicable peaking factors for each use. Most large industrial uses have relatively constant demands so that a 1 mgd recycled water production facility can supply a 1-mgd industrial use (even though it may require some diurnal storage to even out the flow from a 1-mgd wastewater treatment plant). However, irrigation demands have both seasonal and daily peaking requirements. It is not unusual in California for an irrigation demand to drop to zero during wet periods in the winter but increase to 2.5 or more times the average yearly usage during hot summer days. In such situations, if the average yearly usage of an irrigation project is 1 mgd, the recycled water production rate must reach at least 2.5 mgd to supply peak day summer demands or there must be large surface or underground storage facilities available to even out yearly fluctuations. This means that the yield from an irrigation project is substantially less than the yield from a constant rate industrial usage for the same sized treatment facility.

Most landscape irrigation where there is public access must be irrigated during eight or nine hours at night when the public is excluded from the site. Unless there is local storage of the daytime flow, the rate of delivery must be about 3 times the average daily rate of usage. This means that pipelines which distribute recycled water from treatment facilities to landscape irrigation projects must be designed for about 7.5 times the yearly average rate of delivery. This increases the unit cost of delivering recycled water for irrigation, as compared to industrial water. Sometimes, daytime industrial users can be coupled with nighttime irrigation users on the same distribution system to improve the economics of the project.

Figure 2-2
Monthly Golf Course Irrigation Demand as Percentage of Total Annual Demand



It is important to estimate the actual yield of recycled water from a project in relation to the size of the proposed treatment facilities in order to determine an accurate unit cost of production for the water that is actually delivered and sold to customers. An illustration of the monthly variation in irrigation demand is presented in Figure 2-3 for a central California coastal community. Actual recycled water monthly delivery data is included on Table 2-8 for the South Orange area.

Table 2-8 SOCRA Service Area - Recycled Water Produced (acre-feet) 1996

Agency	Facility or Region	Jan-96	Feb-96	Mar-96	Apr-96	May-96	Jun-96	Jul-96	Aug-96	Sep-96	Oct-96	Nov-96	Dec-96	Annual Totals
CBWD		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CVWD		6.72	0.32	2.29	13.43	25.26	64.62	62.45	56.60	40.90	16.40	1.80	1.00	291.79
ETWD	Region 8	9.27	2.77	7.03	43.35	57.66	53.41	62.21	55.98	39.92	20.29	9.71	3.06	364.66
	Region 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IRWD	Region 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LAWD	Region 8	74.85	17.92	24.12	134.86	155.57	155.27	182.88	279.33	165.18	149.47	57.83	29.72	1,427.00
	Region 9	8.19	1.01	1.47	9.80	17.21	14.95	19.03	21.24	19.61	21.41	7.65	3.90	145.47
SCWD		32.89	1.78	22.82	83.92	101.44	116.99	125.39	118.85	95.57	69.69	36.74	7.77	813.85
MNWD	AWMA JRP	32.92	13.23	30.09	93.16	109.12	111.81	150.70	97.94	106.49	148.60	41.02	4.45	939.53
	3-A Plant	11.22	14.00	0.00	0.00	82.00	160.48	168.19	170.12	167.86	109.40	0.00	0.00	883.27
	CTP	9.14	0.00	7.33	12.71	27.29	34.33	38.81	36.23	30.15	26.40	10.54	0.68	233.61
SMWD	Oso Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Chiquita	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Nichols	1.41	1.63	2.05	1.83	1.97	2.31	2.20	2.41	2.21	2.24	1.99	1.61	23.86
TCWD	RRWRP	60.58	57.51	61.40	58.07	59.60	59.15	59.18	58.70	60.66	63.50	64.60	66.20	729.15
TOTALS		247.19	110.17	158.60	451.13	637.12	773.32	871.04	897.40	728.55	627.40	231.88	118.39	5,852.19

2.8 IDENTIFY FACILITY SITING ISSUES AND OPPORTUNITIES

The siting of any public facility is a significant undertaking and requires public support and education. Even before identification of possible locations for treatment, pumping or distribution facilities, it is essential that the sponsoring agency conduct an educational and public information program which documents the need for and value of the project to the community, the environmental benefits, the safety, and nuisance free characteristics of the project. All of these issues also will have to be addressed in the environmental documentation required by CEQA or NEPA, as the project proceeds through the feasibility analysis stage. An effective public information program should be conducted as part of the site planning. Siting options depend upon the size requirements of the facility, the selected treatment processes, the availability of land and its zoning and the nature of the developments surrounding the proposed sites. The primary criteria when siting treatment facilities is finding a location that is well separated from residences or sensitive activities like schools by other public or institutional facilities that are incompatible with the proposed use. The main distribution pipeline criteria is that, where feasible, there should be a ten foot horizontal separation from potable water mains (Health and Safety Code Section 4049).

2.9 CONDUCT AN EVALUATION OF ALTERNATIVE RECYCLING PROJECTS

It is likely that several alternative project concepts will appear during the course of the market assessment and feasibility analysis. For example, there may be more potential users than the available recycled water can supply. There may be alternative treatment schemes, sites for physical facility, and distribution pipelines routes. Cost estimates for each alternative should be developed. A design engineer with experience in designing and constructing water recycling facilities typically prepares feasibility level cost estimates. The cost estimates are generally accurate as this feasibility level of detail of about –30 percent to +50 percent. All of these alternatives, including the "no project" alternative, will have to be analyzed for their environmental impacts in order to comply with the NEPA/CEQA requirement. However, the sponsoring agency will also want to evaluate the economic impacts of each alternative to determine the amount of recycling that can be achieved and the unit cost of producing and delivering the recycled water. This analysis must be completed before the specific project can be selected (see Section 3).

2.10 DETERMINE POTENTIAL ENVIRONMENTAL IMPACTS

Recycling projects will frequently result in some identifiable environmental impacts either because the recycled water will no longer be discharged or because the new use will create changes in the flora or fauna of an area. These environmental impacts may be temporary or permanent. Temporary impacts are usually construction related (e.g., noise, and construction related relocation impacts on building a pipeline). Permanent impacts associated with the siting of physical facilities and relocation of point of discharge may need to be analyzed. If the recycling project expands the available potable water supply, the potential for growth inducements should also be considered.

With increased regional cooperation, environmental benefits can potentially increase. The goal of regional water recycling projects is to transfer water from areas of excess supply to areas of excess demand, identify regional seasonal storage opportunities, and identify partnerships between local water and wastewater agencies. The Orange County case study below is an example of how these partnerships can lead to increased supply of recycled water.

2.11 SELECT AN IMPLEMENTABLE ALTERNATIVE

Although the Feasibility Report should address all potential recycling options available to the agency, the entire plan does not have to be implemented at one time. Some portions of the plan may prove to be uneconomical or precluded by institutional or environmental problems. The normal approach is to identify those portions of the plan, which result in maximizing the amount of water that can be recycled at a reasonable or acceptable unit cost. Key large potential customers of recycled water should be requested to sign letters of intent assuring their willingness to use recycled water. All environmental, permitting, customer assurance, and institutional issues should be identified and addressed to be certain there are no insurmountable objections to the project.

2.11.1 Identify Institutional Arrangements

If the proposed project crosses jurisdictional boundaries, involves more than a single agency, or if the wastewater is not already owned by the sponsoring agency, discussions must be initiated with all potentially involved agencies. Agreements must be negotiated and signed to define the roles each agency will play in the project. This is particularly important where the project sponsor is a wastewater treatment agency or water wholesaler and the recycled water will be delivered to customers of a public or private water purveyor. State Law requires a water supply agency to compensate the local potable water purveyor for any losses incurred due to the recycled water service when serving customers in its area. Such agreements should identify the following terms and conditions of service, such as, compensation, who will read meters and bill for the recycled water; what fee, if any, the local water purveyor will add to the price of the water sold; who will inspect user facilities and be responsible for avoidance of cross-connections; and user compliance with health department requirements.

When the recycled water is treated by an agency other than the project sponsor, a cooperative or partnership arrangement must be developed. The producer of the reclaimed water must commit to quantity, quality and timing conditions that will satisfy the needs of the project customers. The producer of the recycled water may also desire to recover some of his treatment costs or to receive a portion of the savings associated with a project.

2.11.2 Implementation Schedule

The Feasibility Report should include a recommended step-by-step procedure for implementation of the project. Each required action of the agency Board of Directors and other participating agencies should be identified and entered on a time line to provide a clear schedule for accomplishing the project. The person responsible for seeing that each critical action is taken in a timely manner also should be identified in the schedule. The schedule may have to be modified as unexpected issues appear, but it should provide the blueprint for moving to final completion of the project. An illustrative implementation plan from the City of Long Beach is shown on Figure 2-4.

CASE STUDY
ORANGE COUNTY RECLAMATION AND REUSE FEASIBILITY STUDY
EXAMPLE OF REGIONAL COOPERATION

The South Orange County Reclamation Authority (SOCRA), Municipal Water District of Orange County (MWDOC), Coastal Municipal Water District (CMWD), Orange County Water District (OCWD), and the Metropolitan Water District of Southern California (MWD) jointly participated in the development of the Orange County Reclamation and Reuse Feasibility Study in 1996. The goal of the project was to identify regional facilities which could increase the reclamation potential in Orange County.

Based on individual agency projections, without a regional approach to water recycling, the amount of reclaimed water planned was considerably less than the potential demands. The deficit was estimated at 125,000 acre-feet per year in 1990, 63,000 acre-feet per year in 2010 and 80,000 acre-feet per year in 2040. While there was an adequate amount of wastewater flow available to satisfy all of the identified demand, there was insufficient treatment capacity and seasonal storage.

A total of eleven alternative regional projects were identified and evaluated to optimize the use of reclaimed water within Orange County and increase the reliability and flexibility of the existing systems. The criteria used to develop the alternative regional projects included the following:

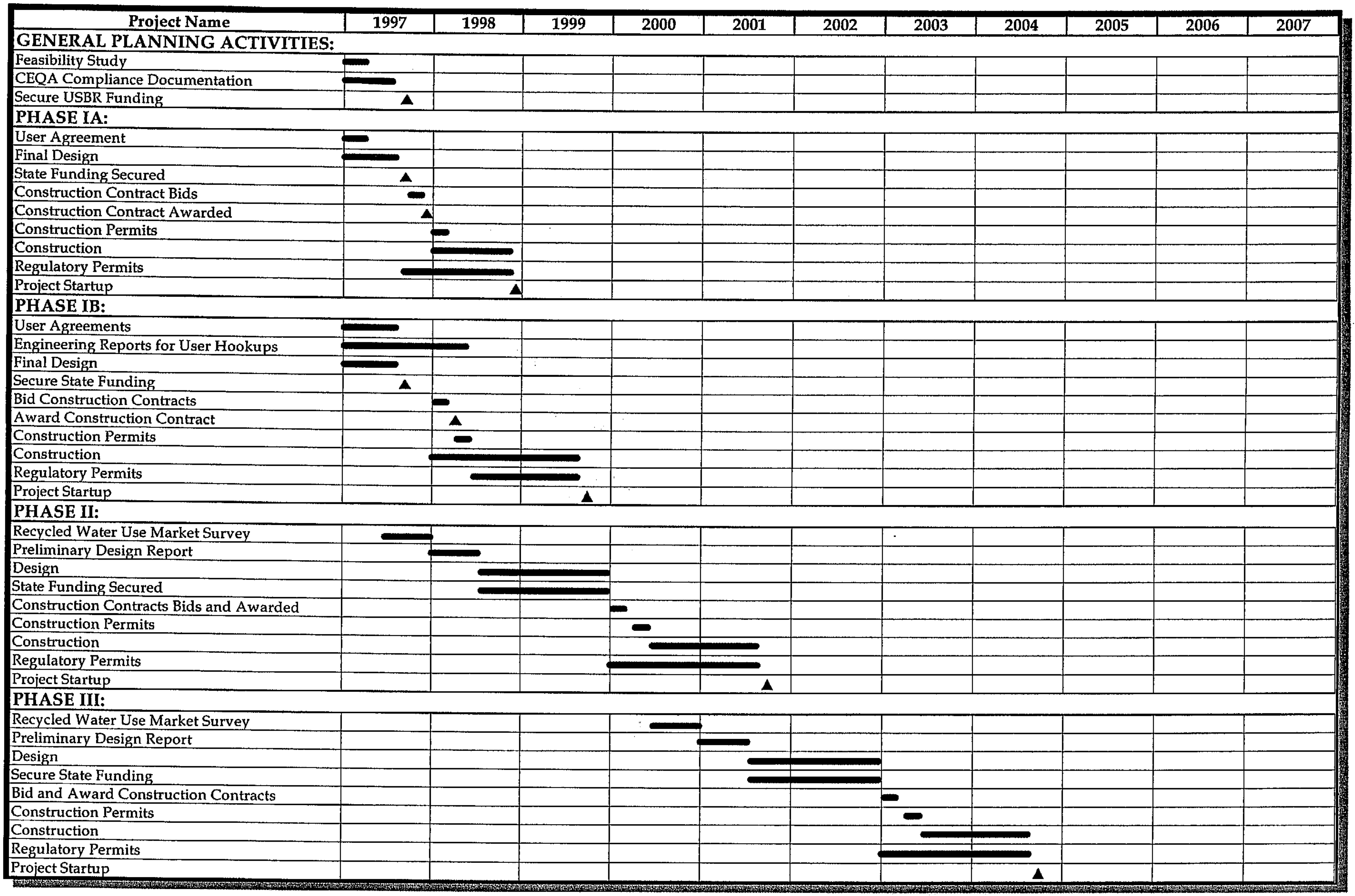
- Eliminate or reduce areas of surplus or deficit of reclaimed water;
- Provide a minimum of two sources of supply for each reclaimed water system, as practical;

- Identify opportunities for sharing existing or future seasonal storage facilities; and
- Optimize reclaimed water sources to minimize pumping.

The economic evaluation of the alternative projects included the development of capital, energy, and total annual costs. The non-monetary factors considered included: technical advantages, regional significance, institutional constraints, regulatory and permitting constraints, and phasing considerations.

Implementation of all of the identified projects had the potential to increase the amount of reclaimed water by an estimated 17,000 acre-feet per year beyond that previously planned. The overall unit cost for the additional reclaimed water use was about $375 per acre-foot, which is reasonable given the cost of new supplies. Since completion of the Orange County Reclamation and Reuse Feasibility Study, several of the individual agencies have been pursuing the identified alternative projects.

Figure 2-3
Long Beach Water Department Water System Expansion Program – Proposed Implementation Schedule



2.12 PARTNERSHIP OPPORTUNITIES

Sometimes water recycling projects have the potential to provide benefits to others in the surrounding areas. In these cases, it may be advantageous to cooperatively work together with other agencies and beneficiaries to develop and implement a water recycling program. These partnership opportunities can be effective in spreading the costs and financial risks commonly associated with a project. One example of a successful partnership for the development of a water recycling project is described below.

East Bay Municipal Water District/Dublin San Ramon Sanitation District

On July 1, 1994, East Bay Municipal Water District (EBMUD) and Dublin San Ramon Sanitation District (DSRSD) entered into a planning agreement to facilitate the development of a joint water recycling program. The agreement was an outcome of a Memorandum of Understanding signed by both Districts in June 1990. Both DSRSD and EBMUD have an interest in developing recycled water projects to address their long-term water supply needs.

A Steering Committee comprised to two representatives from each agency was established to produce various work products and develop recommendations for further implementation of the joint water recycling program.

The work products were:

- A preliminary engineering report to identify the most cost-effective joint recycled water program. This report evaluated treatment, storage and delivery scenarios in both service areas and developed an estimate of the program costs.
- A preliminary environmental assessment to identify potential impacts and determine the need for additional environmental documentation.
- A public outreach effort to facilitate an exchange of information with the affected communities.
- An institutional assessment to determine a viable and implementable arrangement. This assessment investigated appropriate roles and responsibilities of each agency with respect to project financing, design, construction and operation. It included a sample financial plan to show how the project could be financed and when shortfalls and surpluses would occur.

Summary

The Steering Committee recommended that EBMUD and DSRSD create a joint powers agency (JPA) to develop and implement a water recycling program for the San Ramon Valley and portions of the Livermore Amador Valley. The program would comprise one or more projects, including the studying, planning, design, financing, acquisition, construction, operation, and maintenance of facilities. The Steering Committee identified a project to provide 5,860 acre-feet per year of recycled water, with the possibility of evaluating future expansion. The project would cost up to $55 million, with a unit cost to deliver recycled water of up to $1,100 per acre-foot. Expansion of the project could reduce the overall unit cost to $800 per acre-foot. The project could be financed in a number of ways, including loans from the member districts, JPA-issued bonds, and take-or-pay agreements. Staff for the JPA would comprise staff from DSRSD and EBMUD. An extensive public outreach effort would be implemented for the project.

Section 3

DETERMINING COST-EFFECTIVENESS

Cost-effectiveness is an important criterion for assessing the feasibility of a water recycling project. Decisions about the cost-effectiveness of water recycling depend primarily on the costs and the stream of benefits derived from the water recycling project. While there is not single correct way to assess cost-effectiveness, differences in method and assumptions can have a significant impact on the outcome. Utilizing a consistent methodology for cost-effectiveness analysis will provide a uniform systematic estimate of all monetary and non-monetary cost and benefits associated with the project for comparing to other alternatives.

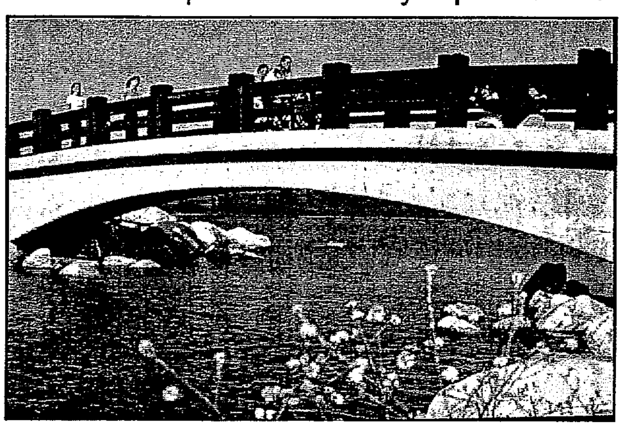
A cost-effectiveness determination is also referred to as an economic analysis. This is distinguished from a financial analysis that determines who pays what portion of the actual costs, what financing mechanisms are used, and whether there are sufficient revenues to meet forecasted costs. Financial analysis will be covered in Section 4.

A cost-effectiveness analysis consists of a systematic method of comparing the costs and benefits of alternative courses of action. Water recycling projects with benefits greater than costs are generally considered cost-effective, those with costs greater than benefits are not. Important policy considerations include the perspective from which the determination will be made and which costs and benefits are to be considered. The cost-effectiveness analysis should identify all costs and benefits of the water recycling project from a total society, federal, state, regional, and local perspective. This will ensure visibility is give to the full range of project effects.

To compare costs and benefits incurred and realized at different points in time, it is necessary to convert each cost and benefit into its equivalent present day value or "present worth." The "discount rate" is the factor used to convert future costs and benefits to a present worth. Water recycling capital costs tend to concentrate in the early years. Whereas, operation and maintenance (O&M) costs and water recycling benefits are spread out over the entire life of the project. The cost-effectiveness of a water recycling project can be sensitive to such variables as the discount rate, O&M costs, and project benefits. Where these parameters depend on certain assumptions, and alternative assumptions are plausible, sensitivity analyses should be conducted. If the results prove sensitive to other plausible assumptions, further efforts should be made to narrow the range of uncertainty.

When comparing different projects, it is important to ensure that they are compared on equal terms so a valid comparison can be made. When comparing two or more projects, the same discount rate, planning period and useful life should be used. The planning period is the period over which the water recycling system is evaluated for cost-effectiveness. The planning period begins in the initial year of operation and generally ends in the 20th year of operation, because it is difficult to estimate much further out into the future. The economic analysis will involved many monetary transactions and analyze the incremental costs and benefits that accrue from the project during the planning period.

Useful life is the estimated periods of time which the individual components of the water recycling system will be operated. This time period is usually equivalent to the time period during which the component is capable of performing if function. For the purposes of this analysis an assumed useful life is generally assigned to categories of components of a water recycling project (e.g., land –permanent; pipelines and structures – 50 years; process equipment – 20 years; and instruments controls, pumps motor – 10 to 15 years).



Key Definitions in Decision Making Analysis

Cost-Effectiveness

Cost Effectiveness is defined as the analysis of alternatives using an effectiveness scale as a measurement concept. US EPA formulated "Cost-Effectiveness Analysis Guidelines" as part of its Federal Water Pollution Control Act (40 CFR Part 35, Subpart E, Appendix A). Cost-effectiveness techniques require the establishment of a single base criteria for evaluation, such as annual water production of a specific quality expressed as an increase in supply or decrease in demand. Alternatives are ranked according to their ability to produce the same result. Considerations effecting a determination of cost-effectiveness can include such factors as the impact on quality of life, environmental affects, etc., which may not be factored into a cost/benefit analysis (see also "Guidelines to Conduct Cost-Effectiveness Analysis of Best Management Practices for Urban Water Conservation," the California Urban Water Conservation Council, September 1996).

Cost/Benefit

Cost/Benefit is the relationship between the cost of resources and the benefits expected to be realized using a discounted cash-flow technique. In order to provide a fair comparison, it is essential that non-monetary issues (e.g., environmental and aesthetic impacts, reliability of supply, etc.) be given dollar values and included in the costs and benefits.

Financial Feasibility

Financial Feasibility is the ability to finance both the capital costs and operating/maintenance costs through local revenues, state loans, and federal grants. Typically, a cash flow analysis plus capital budgeting is needed to evaluate financial feasibility. Examples of local revenue sources include water (and wastewater) rates and charges, bonds, taxes, and general utility operating revenues.

Present Worth (or Value)

Present Worth (or Value) is a method of discounting the value of future costs and benefits back to the present by applying an assumed interest rate over the number of years between the present and future expenditure. (See Section 3.4.1)

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3.1 STEP 1: IDENTIFY WATER RECYCLING COSTS AND BENEFITS

Five perspectives should be considered when identifying the costs and benefits of water recycling:

1) Local agency responsible for wastewater treatment and disposal (**Producer**);
2) Local agency responsible for delivery of the water supply to the end user (**Supplier**);
3) Regional wholesale water supplier (**Wholesaler**);
4) State and Federal Government; and
5) **Total Society.**

The following table delineates cost/benefit categories relevant to each perspective for a typical water recycling project. Specific costs and benefits that should be considered are discussed below.

Costs and Benefits from Different Perspectives

	Perspective				
	Producer	Supplier (Purveyor)	Wholesaler	State Feds	Total Society
COSTS					
Producer Costs	X				X
Purveyor Costs		X			X
Financial Incentives			X	X	X
External Costs			X	X	X
BENEFITS					
Avoided Wastewater Treatment/Disposal	X				X
Avoided Water Supply Costs		X	X	X	X
Water Supply Reliability Benefits		X	X	X	X
Financial Incentives	X	X			X
External Benefits			X	X	X

3.1.1 Costs

Cost should be identified by determining the resources needed to implement a water recycling project. The appropriate measure is incremental costs that are determined by comparing the costs that would occur if the water recycling project were implemented with the costs that would occur if it were not implemented. Incremental costs do not include future costs that would occur event if the project were not implemented.

Producer Costs

Producer costs include the cost to treat the recycled water and deliver it to the supplier, less the cost to treat and dispose of the wastewater in compliance with NPDES or waste discharge permit conditions. These can be measured in term of costs of capital equipment and materials, O&M, chemical processing, pumping, energy, and administration in excess of that required to comply with NPDES permit conditions.

Supplier (or Purveyor) Costs

Supplier costs include the cost of the water purchased from the producer plus the cost to deliver the water to the intended use area, plus salvage value of potable water system assets permanently stranded as a result of the use of recycled water. These can be measured in terms of costs of capital equipment and materials, O&M, pumping, energy, customer retrofit, monitoring, reporting and administration.

Financial Incentives

Financial incentives are financial contributions to the project paid by the wholesaler, state, or federal agencies to the producer, supplier, or both, to encourage water recycling. Wholesaler rebates and state and federal grants should be analyzed as a cost from the perspective entity. From the total society perspective, these financial incentives should be treated as equal costs and benefits that sum up to zero.

External Costs

External costs are those incurred by society but not accounted for in the transaction between the producer, supplier, and customer, including any harmful effects to the environment, or costs incurred by other utilities and their customers. For example, use of recycled water in the upper reaches of the watershed may increase the cost of water treatment for the down gradient water supplier. Increased diversion of fresh water from a stream may result in adverse impacts to the aquatic environment.

Sunk Costs

Sunk costs are costs that have already been incurred and are not reversible. Generally, project costs should not include sunk costs. An exception to this general rule is the inclusion of the salvage value of potable water system assets permanently stranded as a result of the use of recycled water. This will ensure visibility is give to the full range of project effects.

Lost Revenue

The identification of cost should not include revenue "lost" from reduced sales of potable water as a cost of water recycling. From the perspective of the total society, the revenue "lost" by the supplier due to a reduction in potable water sales is "regained" through the sale of recycled water. From the supplier's perspective, any difference in revenue is recovered with adjustments in rates and charges, therefore, there is no loss to the supplier. Water recycling is effectively a long-term supply measure, while unrecoverable revenue is a short-term phenomenon. Inclusion of the salvage value of permanently stranded potable water assets as a project cost will account for the short-term lost revenue phenomenon.

3.1.2 Benefits

Benefits should be identified when determining the positive consequences of water recycling. The appropriate measure is incremental benefits, which are determined by comparing the benefits that would occur if it were not implemented. Incremental benefits do not include future benefits that would occur even if the project were not implemented.

Producer Avoided Wastewater Treatment and Disposal Benefits

Producer avoided wastewater treatment and disposal benefits result from deferring, eliminating or downsizing projects to provide future wastewater treatment as a result of the water recycling project. These can be measured in terms of avoided costs of capital equipment and materials, O&M, chemical processing, pumping, energy, and other costs associated with compliance with NPDES or waste discharge permit conditions.

Supplier Avoided Water Supply Benefits

Supplier avoided water supply benefits result from deferring, eliminating or downsizing a project to provide future water supply as a result of the water recycling project. These can be measured in terms of avoided costs of capital equipment and materials, O&M, chemical processing, pumping, energy, and compliance with environmental regulations. The supplier's avoided costs may also include reduced water purchases from a wholesale supplier. Avoided supply costs should be expressed as the marginal costs of the water development and delivery into the supplier's system. If the avoided supply would have come from a wholesale supplier, the marginal cost from the suppliers perspective is the rate paid to the wholesaler. Often, a wholesaler's rates reflect the average cost of all the wholesaler's supplies ("melded rate"). The melded rate may not fully reflect the avoided water supply cost from the wholesaler, state, federal, or total society perspective. From the wholesaler, state, and federal perspective, the avoided cost is that actually incurred in the development and delivery of the next increment of supply. From the total society perspective, the avoided cost should be the true marginal cost of the avoided supply.

Water Supply Reliability Benefits

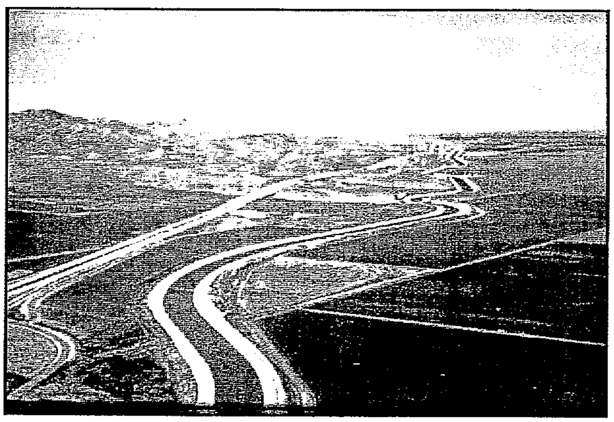
Water supply reliability benefits include the value of decreased probability and severity of water shortages. The wholesale supplier, or regional water supplier, state and federal government and total society all may benefit from improved system reliability Since water recycling is one way to improve system reliability, avoided shortage costs constitute a valuable benefit to suppliers and wholesalers. A practical, though imperfect, method for establishing the value of reliability to the supplier and the wholesaler is to assume that the financial incentives available from the water supply wholesaler are a quantification of the value of reliability.

Avoided Cost Versus Reliability

It is also important not to double count reliability benefits and avoided supply costs. If the recycled water supply is being developed as a hedge against future droughts, and is not being used to meet additional demand, then the recycling project is not reducing the need for new supply options but is enhancing reliability. Alternatively, if recycled water is used to meet increasing demand and reduce the need for new supply sources, then the recycled water improves reliability only to the extent it is more reliable than the supply it replaced.

Financial Incentives

Financial incentives are financial contributions received by the producer, supplier or both, from the wholesaler, state or federal agencies to encourage water recycling. Wholesaler rebates and state and federal grants should be analyzed as a cost from the perspective of the funding entity and as a benefit from the perspective of the receiving entity. From the total society perspective, these financial incentives should be treated as equal costs and benefits that sum up to zero.



External Benefits

External Benefits are those enjoyed by society but not accounted for in the transaction between the producer, supplier and customer, including benefits to the environment, other utilities and their customers. An investment in recycled water may solve many problems simultaneously. For example, a water recycling program may result in reduced diversions from the Sacramento San Joaquin Bay-Delta which provides an improved water supply reliability for all dependent on the Delta for water and improved environmental conditions within the Delta. A recycling program may result in reduced water purchases from an external supplier and increased local investment in water resources that creates jobs, tax revenue and an overall boost to the local economy. Additionally, water recycling may improve a local or regional water quality control problem or help restore a wetland or marsh. Society benefits from water recycling that avoids environmental impacts.

3.2 STEP2: MEASURE AND VALUE PROJECT COSTS

Recycled water production costs include the cost to treat the recycled water, less the cost to treat and dispose of the wastewater in compliance with NPDES or waste discharge permit conditions. Recycled water treatment typically involves polishing the effluent from a wastewater treatment plant to bring it into compliance with state regulations or meet specific user needs. These costs can be measured in terms of capital equipment and materials, operation and maintenance, chemical processing, pumping, energy and administration in excess of that required to comply with NPDES or waste discharge permit conditions. Costs appropriately allocated to wastewater treatment are those necessarily incurred by the discharger for treatment and disposal of its effluent. Such costs typically include primary and secondary treatment and, under certain conditions, may include additional treatment such as disinfection, nutrient removal, filtration, or demineralization.

Recycled water delivery costs include the cost to deliver the recycled water to the intended use area, plus salvage value of potable water system assets permanently stranded as a result of the use of recycled water. Delivery systems consist of pumping stations, pipelines and storage facilities that convey water to customers. These can be measured in terms of costs of capital equipment and materials, operation and maintenance, pumping, energy, customer retrofit, monitoring, reporting and administration.

Capital costs include the initial construction cost for all treatment, distribution and retrofits included in the project. Replacement costs are capital costs that are incurred after the project is in operation as a consequence of some facilities exceeding their useful lives before the end of the evaluation period. Operation and maintenance costs are incurred yearly as long as the project is in service. They can be divided into "fixed" and "variable" costs. Fixed costs are those costs which will be incurred regardless of how much water is being recycled such as the labor for the plant operator. Variable costs, such as chemical usage and power, tend to be proportional to the amount of water treated or delivered.

Over the years, most engineering firms and the EPA have produced curves comparing the capital and O&M costs to the size of treatment facility for various types of wastewater (primary, secondary and tertiary) treatment processes. These curves are generally conservative and tied to an Engineering News Record Construction Cost Index (ENR-CCI).[1] Appendix 6.4 includes the ENR-CCI indexes for San Francisco and Los Angeles. There are also curves for the cost per unit of length for laying various types of sewer or water distribution pipe related to pipe diameter, depth of cover, presence of paving and other relevant factors. These curves can be useful in making a first approximation of the potential costs before engineering design begins. Costs from the curves are escalated to the projected midpoint of construction based on the projected rate of change in the ENR-CCI.

3.2.1 Tertiary or Supplemental Treatment Costs

The production and use of reclaimed water is carefully controlled through state laws and administrative regulations. The California Department of Health Services (DHS) is responsible for the adoption of regulations for the use of reclaimed water. The Regional Water Quality Control Boards (RWQCB) issue reclamation requirements for individual water reclamation projects in conformance with the regulations adopted by the DHS.

The DHS is charged with the responsibility for establishing uniform statewide reclamation criteria to ensure that the use of reclaimed water will not be detrimental to public health. The DHS is required to establish uniform statewide reclamation criteria for each varying type of use of reclaimed water where the use involves the protection of public health. Requirements for a use of reclaimed water not addressed by the uniform statewide criteria are established by the DHS on a case-by-case basis.

1 Cost indices are used to measure the relative change in cost of a commodity or category of commodities over time. The ENR-CCI is commonly used in the civil engineering field. Cost indices are a useful cost estimating tool to convert cost data obtained from different locations and applicable for different dates to constant dollars at a given date and location.

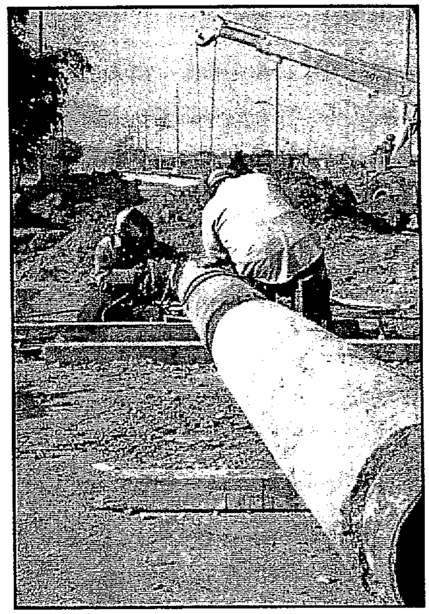
The DHS establishes water quality standards and treatment reliability criteria for water reclamation operations in Title 22, Chapter 4, of the California Code of Regulations. The intent of the Title 22 regulations is to establish uniform statewide reclamation criteria in order to ensure that the use of reclaimed water for the specified purposes does not impose undue risks to health. The regulations set forth acceptable levels of constituents of reclaimed water and prescribe methodology for assuring reliability in the production of reclaimed water.

The existing Title 22 reclamation criteria were adopted by the DHS in 1977. Since that time, the use of reclaimed water greatly expanded and water treatment technology achieved considerable advances. The DHS has developed proposed revisions to the Title 22 reclamation criteria. The revisions are intended to expand the range of allowable uses of reclaimed water and clarify the existing requirements. Most, if not all, of these applications are already being permitted on a case-by-case basis today.

For recycled water applications with a high likelihood of public exposure, Title 22 generally requires a tertiary treated recycled water supply. Traditional tertiary treatment involves the flocculation, filtration and disinfection of secondary effluent. Tertiary treatment costs typically range from \$300 to \$400 per acre-foot (ENR 6673.5 for Los Angeles Area). These costs can be broken down as follows: 70 percent for capital equipment, 15 percent for fixed operation and maintenance costs, 10 percent for variable operation and maintenance costs and 5 percent for administration.

Additional treatment may be required to satisfy DHS or an individual user's water quality requirements. For example, industrial customers may need supplemental chemical, biological, and physical treatment to meet certain water quality criteria. Groundwater recharge applications, where the recycled water is injected directly into the aquifer, may require the use of organic carbon removal technology such as Granular Activated Carbon (GAC) at a cost of \$100 to \$250 per acre-foot or reverse osmosis (RO) treatment at a cost of \$350 to \$650 per acre-foot (ENR 6673.5 for Los Angeles Area).

3.2.2 Distribution Costs



The cost of distribution is directly dependent on the distance to customers and the volume of their demand in relation to the available supply of recycled water. The routes of distribution pipes are usually determined by the location of the large volume customers. Obviously, long distances between customers will significantly increase the capital cost for construction, as well as the operational pumping costs. It is useful to calculate the cost per foot of distribution system pipeline for varying quantities of usage, in order to estimate how close a certain sized customer must be to have an economical delivery system.

3.2.3 Storage Costs

Diurnal storage of recycled water also needs to be considered. Irrigation users typically use recycled water at night (9:00 P.M. until 6:00 A.M.) when the diurnal flows at most wastewater treatment plants are at their lowest (generally 2:00 to 6:00 A.M.). Therefore, daytime storage is often required for nighttime delivery. Certain irrigation customers, golf courses in particular, are able to provide for their diurnal storage needs on site. Industrial customers sometimes provide on-site storage or a potable back-up supply (or both) in order to be sure of having an adequate supply when irrigation demands on the system are high. Diurnal storage facilities can include open reservoirs at $0.40 to $0.65 per gallon, or steel and concrete tanks at $0.60 to $0.85 per gallon (ENR 6673.5 for Los Angeles Area).

Seasonal storage may also be needed for the recycled water system to operate at optimum efficiency. Typically, during the summer months the available recycled water is fully utilized. In the winter months, however, when the irrigation demands are low, there is frequently a surplus supply of recycled water available. Where appropriate, the project assessment should evaluate the feasibility of groundwater recharge or impounding the surplus recycled water production. The cost of such facilities is site-specific in nature.

3.2.4 Monitoring and Reporting Costs

The RWQCBs are responsible for surveillance and monitoring to ensure that the reclaimed water use is in compliance with water recycling requirements. Typically, water recycling requirements issued to the supplier and/or the end-user of the recycled water include the following provisions:

1) The storage, delivery or use of reclaimed water shall not result in a pollution or nuisance, or adversely affect water quality.
2) The delivery or use of reclaimed water shall be in conformance with the Title 22 criteria.
3) Prior to delivering recycled water to any new user, the permittee shall submit to the RWQCB a report discussing the delivery system, the use for which the recycled water is intended, and plans to assure that no untreated or inadequately treated recycled water will be delivered to the use area.
4) The permittee shall establish and enforce rules and regulations governing recycled water users.
5) The user shall designate an on-site supervisor responsible for the operation of the recycled water system. The supervisor is responsible for the installation, operation and maintenance of the irrigation system; enforcing the water recycling requirements; prevention of potential hazards; and maintenance of a set of distribution system plans in "as-built" form.
6) The designated supervisor is responsible for reporting any non-compliance to the RWQCB within 24 hours of becoming aware of the circumstances.
7) The permittee shall submit to the RWQCB a quarterly report that summarizes recycled water use.
8) The permittee shall conduct periodic inspections of the facilities of the recycled water users to monitor compliance with the uniform reclamation criteria.

The specified frequency of sampling and the number and types of analyses to be performed are negotiated with the RWQCB staff before issuance of the permit. Monitoring requirements can add $85,000 to $350,000 per year to the cost of operating the recycling project and should not be overlooked when calculating total project costs (ENR 6673.5 for Los Angeles Area).

3.2.5 Retrofit/Plumbing Costs

The cost of retrofitting the end-users plumbing to accommodate recycled water should also be taken into consideration. Retrofit costs vary widely from a low of $40 per AF/Y to a high of $100 per AF/Y of recycled water demand. Golf course retrofits may be relatively more expensive if potable water is needed for the greens. Industrial retrofit costs are very site specific and will vary widely. A typical cost of $60 per AF/Y can be used for feasibility assessment purposes. However, it is important to verify onsite retrofit costs in the pre-design phase of project implementation. The project sponsor will need to decide who should pay the cost of retrofitting the end-user's property. In situations where the use area is currently being served with potable water, the project sponsor may want to assume some or all of the financial responsibility for retrofit costs to eliminate a potential disincentive for end-users to convert to recycled water. In areas where recycled water may be available, state law requires that new development be plumbed so that recycled water may be provided to the nonpotable uses onsite (Water Code 13550).

3.2.6 Engineering, Environmental and Contingencies

After a total cost has been established for the capital facilities, it should be marked up by 15 to 25 percent to account for engineering, construction management, inspection, environmental compliance, profit and overhead. This figure should then be marked up again by 20 to 50 percent to provide for contingencies depending upon the complexity of the project construction and level of uncertainty with cost estimates that may arise during design and construction. Once the engineering design is completed, the design engineer should be in a position to prepare a more accurate cost estimate based on the actual site and design conditions.

3.3 STEP 3: MEASURE AND VALUE PROJECT BENEFITS

Benefits of water recycling are identified by determining the positive consequences of project implementation. The appropriate measure is incremental benefits which are determined by comparing the benefits that would occur if the water recycling project were implemented with the benefits that would occur if it were not implemented. It is possible that some of the benefits predicted to occur in the future with the project may have occurred even without the project. These benefits should not be attributed to the project.

The benefits derived from a recycling project are both internal and external. Avoided water supply and wastewater treatment and disposal costs and improved water supply reliability are examples of internal benefits. Improvements to the environment and economy are of external benefits.

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Identifying Potential Benefits

1. INTERNAL BENEFITS

WATER SUPPLY

- Reduced (potable) water system O&M expenditures (energy costs for transmission and distribution pumping and chemical costs for treatment).
- Reduced water utility system capital costs by delaying or avoiding future improvements due to lower volume of potable demands. Capital improvements include supply storage plants, distribution pipelines, and distribution storage and pumping.
- Reduced costs of purchasing imported water (e.g., water transfers).

WASTEWATER SYSTEM

- Reduced wastewater O&M (particularly in the area of treatment and disposal costs, if additional treatment and pumping is required to meet discharge permit requirements without water recycling).
- Reduced capital costs for wastewater treatment and disposal.

2. EXTERNAL BENEFITS

External benefits are those enjoyed by society, but not accounted for in the transaction between the producer, supplier, and customer, including benefits to the environment, other utilities and their customers. An investment in recycled water may solve many problems simultaneously.

- Water recycling may result in reduced diversions and improved environmental condition of sensitive water bodies.
- The reduced cost and increased reliability of recycled water may help retain industries considering a move from the community or attract new water using industries to the community.
- Water recycling may result in reduced water purchases from an external supplier and increased local investment in water resources that creates jobs, tax revenue and an overall boost to the local economy.
- Water recycling may improve a local or regional water quality control problem, restore a wetland or marsh, or create recreational opportunities.
- Water recycling may improve water supply reliability through decreased probability and severity of water shortages.
- Water recycling may reduce wastewater discharges and associated waste loads to the ocean, lakes, and stream.

Where the benefits being valued are traded in the marketplace (i.e., avoided cost of water transfers), market prices provide the basis for estimating the dollar value of the benefits. When markets do not exist, alternative methods should be used, such as those discussed below.

3.3.1 Avoided Water Supply Costs

Avoided water supply costs should be determined by identifying the new supply project or purchase that is deferred, downsized, or eliminated because of the water recycling effort. This supply must be a realistic alternative to water recycling. Costs of avoided supply projects should be expressed as marginal costs, the cost for each additional acre-foot of water supplied. Marginal cost is comprised of marginal capital cost (capital equipment and facilities) and marginal operating cost (energy, labor, chemical, etc.).

If the highest cost source of supply to a retail supplier comes from a wholesaler, the marginal cost from the **Supplier Perspective** is the actual rate paid to the wholesaler. Often a wholesaler's rates reflect the average cost of the wholesaler's entire existing supplies. However, these rates would not fully reflect the total society's marginal costs of new supply. From the **Total Society Perspective**, the marginal cost should be the highest cost of planned new supply to the wholesaler (statewide projects like CALFED).

3.3.2 Avoided Cost of Wastewater Treatment and Disposal

The avoided costs of wastewater treatment and disposal result from deferring, eliminating or downsizing future wastewater treatment projects. For example, water recycling may eliminate or defer the need to build an ocean outfall or expand the treatment works for disposal. These can be measured in terms of avoided costs of capital equipment and materials, O&M, chemical processing, pumping, energy, and other costs associated with compliance with NPDES or waste discharge permit conditions.

3.3.3 Improved Water Supply Reliability

The benefits of improved water supply reliability derive from the decreased probability and severity of shortages, which impose costs on customers and suppliers. Since water recycling is one way to improve system reliability, avoided shortage costs constitute a valuable benefit to customers. Several methods have been used to value improved system reliability. [2] A practical, though imperfect, working assumption for valuing reliability without double counting is to assume that the value of improved reliability from the **Supplier Perspectives** is implicit in the evaluation of financial contributions received from the wholesaler, state, or federal agencies to encourage water recycling. Wholesaler rebates and state and federal grants should be analyzed as a cost from the perspective of the funding entity and as a benefit from the perspective of the receiving entity. From the total society perspective, these financial incentives should be treated as equal costs and benefits that sum up to zero.

3.3.4 External Economic Environmental Benefits

External economic and environmental benefits constitute a special class of externality because they are often difficult to identify, measure and value. External economic and environmental effects often occur outside the boundaries of the supplier's service area but within the state. Therefore, a statewide perspective is likely to be adequate for determining most environmental benefits.

To measure economic and environmental benefits, the cost effectiveness analysis should estimate what would happen with and without the water recycling project. This involves judgments concerning how both natural systems react to changes. Even with substantial resources, it is often difficult and time-consuming to reliably measure and value external economic and environmental benefits. Where this is the case, in lieu of measurement and valuation of external economic and environmental benefits, the following approach is recommended:

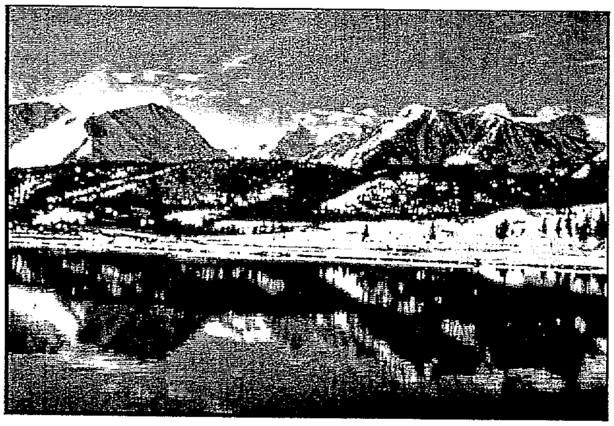
[2] Two recent reports by the California Urban Water Agencies have measured and valued shortage costs for industrial and residential customers: "The cost of Industrial Water Shortages," Spectrum Economics (1991); "The Value of Water Supply Reliability: Results of a Contingent Valuation Survey of Residential Customers," Barakat & Chamberlain (1994).

1. **Screening**
   Assess the need to measure and value external economic and environmental benefits. If a water recycling project is cost-effective (benefits exceed costs) before external economic and environmental benefits have been included, then there is no need to measure the value of external benefits.

2. **Break-even Analysis**
   Calculate the break-even value and make a judgment about its importance. If the water recycling project is not cost-effective (costs greater than benefits) before external economic and environmental benefits have been included, calculate the difference between costs and benefits (the break-even value). Then make a judgment about whether the break-even value is important by comparing it to the costs, benefits and other measures of comparison. The break-even value indicates how big the external economic and environmental benefits would have to be for benefits of the water recycling projects to be at least as great as its costs (to break even). If the break-even value is not very large, it may be possible to reach certain conclusions as to whether the external economic and environmental benefits exceed the break-even value. If the external benefits are valued greater than the break-even value, then the water recycling project is cost effective.

3. **Economic and Environmental Externality Description**
   Describe external economic and environmental benefits of the water recycling project by:

   - Identifying and quantifying increased jobs, tax revenue and other stimulus to the local economy derived from the local investment in the water recycling project; and
   - Identifying and quantifying sources of new water supply that would be reduced during the period of analysis and external environmental costs of the new supply sources (the external environmental benefits associated with the water recycling project).



When identifying and describing external environmental benefits of water recycling, it is important to determine the source of the avoided water supply. The following table shows the different types of environmental benefits associated with different supply sources. [3]

Typical External Environmental Benefits of Water Recycling

Bay-Delta Estuary	Eastern Sierra	Groundwater
➢ Ecosystem Restoration ➢ Improved Water Quality ➢ Reduced Seawater Intrusion ➢ Improved Supply Reliability	➢ Ecosystem Restoration ➢ Improved Water Quality ➢ Improved Air Quality	➢ Reduced Overdraft ➢ Lower Energy Consumption ➢ Reduced Seawater Intrusion

3.4 STEP 4: ECONOMIC ANALYSIS

The economic analysis enables the project sponsor to compare costs and benefits incurred and realized at different points in time. Through a method known as "discounting," the "streams" of costs and benefits over time are converted into their equivalent present day value and summed. A water recycling project is considered cost-effective if the present value of benefits is greater than the present value of costs.

The objective in performing an economic analysis is to determine the real resource cost, as measured in monetary terms, of project alternatives. Dollars of common value should be used in valuing costs and benefits realized at different times. The valuation of costs and benefits should not be inflated with time, they should be held constant over the life of the analysis. The impact that inflation may have on project feasibility will be considered in the financial analysis (Section 4).

[3] For a detailed discussion of environmental impacts associated with water supply development see "California Water Plan Update" Volume 1, Bulletin 160-93, California Department of Water Resources, October 1993.

To compare project alternatives with different costs, benefits, and time distribution of these costs and benefits, the costs and benefits are converted to their equivalent present value (their equivalent value if spent today). A discount rate is used to compute the present value of a cost or benefit that is incurred or realized in a year other than the first year of the analysis. The discount rate is a representation of the time value of money. It is used to adjust dollars received or spent at different times to dollars of a common value, usually present day dollars ("present worth" or "present value").

Since typical water recycling costs tend to concentrate in the early years and benefits are spread out over the entire life span of the project, the discount rate has a particularly important impact on water recycling benefits. A local agency's typical cost of borrowing (revenue bond interest rate) or investing the money long-term are representative of an appropriate discount rate of six (6) percent (the SWRCB is currently recommending a six (6) percent discount rate). Appendix 6.5 illustrates the sensitivity of changing the discount rate from five (5) to ten (10) percent

Most potential water reclamation projects require the sponsor to choose from two or more alternative schemes. For some, it is simply a choice between a "no project' alternative and a specific recycling proposal. For others, it can be more complex as there may be several optional ways to implement recycling. The alternatives often involve different facilities, treatment options, distribution routes, or timing. In order to compare such diverse alternatives, engineering economists have developed the Present Worth (or Present Value) approach as the fairest method of comparing alternatives. After determining what all of the potential costs and benefits of an alternative are and when each will be expended or realized, the costs and benefits are converted to their equivalent value in today's dollars (i.e. their present worth).

Present Worth (or Present Value) can be established by using the formulas or tables available in most engineering economic texts to derive the Present Worth Factor (PWF) for either a single sum expended or received in some future year, "n" years from now, or a series of uniform annual payments or receipts. It may also be referred to as the "discount factor." Regardless of what it is called, it represents the amount of money "P", invested at interest (or discount) rate "i", which will appreciate to the sum "S", to be expended in year "n". In other words, P is the present worth of a payment of S, "n" years from now. For a single payment, it is obtained by multiplying the sum "S" by the PWF for the applicable "n" and "i" under consideration. The formula for the PWF for a single payment is:

$$PWF = \frac{1}{i\left(1+i\right)^{n}}$$

For a uniform annual series of payments, “R” over “n” years, PWF_R is:

$$PWF_R = \left[\frac{\left(1+i\right)^{n}-1}{i\left(1+i\right)^{n}}\right]$$

For further information on the development and application of Present Worth Analyses, the reader is referred to the current edition of Grant's Principles of Engineering Economy (1970), DeGarmo's Engineering Economy (1967), or Douglas and Lee's Economics of Water Resources Planning (1971). For the purposes of a feasibility study economic analysis, the PWF can be obtained from a book or calculated from the above formula and used in a spreadsheet as shown in the following examples.

After the present worth of all identifiable/quantifiable benefits have been subtracted from the present worth of all quantifiable costs, a positive number would indicates that the quantifiable costs exceed the quantifiable benefits. At this point, the sponsor must consider whether there are intangible benefits which can be converted by any of several operations research techniques into a dollar value so that it can be entered into the analysis. Or conversely, whether the subjective judgment of the sponsors values the intangible benefits as equal or greater than the net positive cost of the reclamation project. Another approach is to consider how to reduce the cost of the project by altering its size or characteristics. If the preferred alternative is still considered viable, the analysis can then move on to the financial analysis stage (Section 4).

3.5 STEP 5: SENSITIVITY ANALYSIS

In analyzing uncertainty, cost effectiveness analyses should determine how different assumptions used in the calculations influence the predicted results. The analysis should also attempt to account for inherent variability in costs and benefits, especially when they result from shifts in weather or market forces.

Where benefits or cost estimates heavily depend on certain assumptions, the assumptions should be made explicit. Where alternative assumptions are plausible, sensitivity analyses should be based on plausible assumptions. If the results prove sensitive to alternative plausible assumptions, further efforts should be made to narrow the range of uncertain variables.

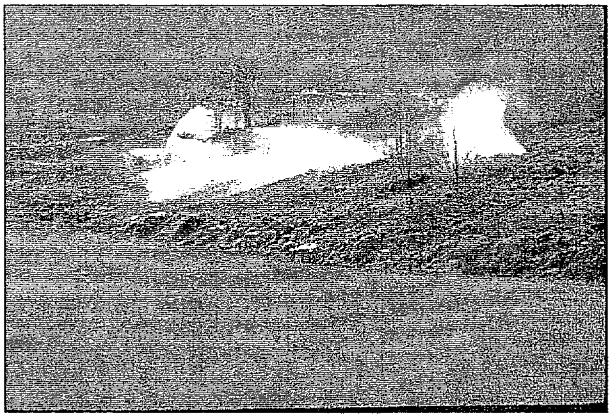
For a water recycling project, the cost-effectiveness analysis should typically investigate the sensitivity to such variables as the discount rate, estimated program costs, and projected program benefits. Because discount rates constitute an important source of uncertainty in the cost-effectiveness analysis, sensitivity analyses should be conducted to test results over a range of discount rates of plus and minus two (2) percent. Any other cost factors that could vary over a wide range should be carefully examined to test the sensitivity of different assumptions of these cost impacts.

3.6 APPLICATION OF PRINCIPLES

These water recycling feasibility assessment guidelines are intended to promote standard methodology for determining cost-effectiveness of water recycling that would lead to uniform decision making. This section has provided general guidance that is applicable to all water recycling projects. The guidelines have covered each step of the cost-effectiveness analysis methodology relevant to water recycling:

Step 1	**Identify Costs and Benefits,**
Step 2	**Measure and Value Costs,**
Step 3	**Measure and Value Benefits,**
Step 4	**Economic Analysis, and**
Step 5	**Sensitivity Analysis**

The discussion that follows provides examples of applying these principles to specific recycling projects.



In order to provide a step-by-step illustration of how one might construct an economic analysis table and estimate the potential unit cost of the water produced by a recycling project, two hypothetical examples have been developed: one for a small system (500 AF/Y capacity) and one for a medium sized system (5,000 to 7,500 AF/Y capacity). The examples include a set of assumptions which define the nature and size of the project, tables of assumed costs and benefits, and the present worth analysis of the data over a 25 year period.

The Small Project 500 AF/Y

ASSUMPTIONS:

- The wastewater and water supply systems are both owned and operated by the Local Municipal Water District (LMWD).
- All recycled water will be used for irrigation of landscaping including a golf course, a regional park and 3 schoolyards.
- The treatment facility exists and has a current flow of over 2 mgd. The existing wastewater treatment plant discharges to an ephemeral stream and meets Title 22 requirements for body contact recreation. The RWQCB is in the process of revising NPDES requirements to limit nitrogen levels discharged to the streambed to less than 10 mg/L. [NOTE: Because this is a small plant, the example has been prepared for discharge to a stream rather than the ocean, since most ocean discharges in California are by medium-sized or large-sized facilities.].

- The treatment plant is located within 5 miles of a golf course and within a reasonable distance of the route to the golf course there are 3 school yards and a regional park, each of which can be served with 8-inch laterals less than 1,000 feet long. The irrigation requirement is 2.5 feet per year. The golf course uses 200 AFY of potable water, the park uses 150 AFY, and the schoolyards have a total irrigation requirement of 150 AFY. The distribution system to the golf course and other users requires five miles of pipeline and a pumping station with a peak capacity of 3 mgd because there are no lakes or storage facilities available. All irrigation will be conducted during the eight hours between 10:00 p.m. and 6:00 a.m. There is a 200-foot lift to the golf course.
- The retrofit costs for substituting reclaimed water for potable water on the golf course ($65,000), park ($40,000) and three school yards ($15,000 each) are estimated to total $150,000.
- The current price of imported potable water is $543 per acre-foot to customers. However, LMWD only pays $325 to the regional importing agency for the water.
- Present worth costs will be compared based on 25 years of water deliveries and a discount interest rate of 6 percent (see Appendix 6.5).
- Potable water imported water pumping costs assume SWP deliveries to Southern California (approximately 3,000 kWhr/acre-foot) and pumping energy for recycled water is approximately 300 kWhr/acre-foot.

ALTERNATIVES:

There are two alternative courses of action being considered by the LMWD:

1. **No Project Alternative:** Continue to import water from a regional source.
2. **Recycling Alternative:** Replace 500 AF/Y of imported water with recycled water from the wastewater treatment plant.

In order to decide whether the water recycling project has an economic benefit over the current water supply, the net present worth of the costs and benefits to the agency of continuing to import and use a potable supply for irrigation purposes must be compared with the net present worth costs and benefits of delivering recycled water to selected irrigation customers. This can either be done by:

1. Developing present worth cost analyses for each alternative (i.e. the no project alternative and the proposed recycling alternative) and comparing the resulting net unit costs of water (or net total present worth costs). The alternative with the lowest net unit cost is presumed to be the most cost effective, unless there are intangible (or total society) benefits that are considered of sufficient value to override the comparison.
2. Looking only at the recycling alternative with all of the cost savings of not purchasing imported water treated as a benefit in a single net present worth analysis. In this case, the question is whether the net present worth of the cost of the project is positive or negative. If it is positive,

the costs exceed the benefits. Again, there may be intangible benefits perceived by the sponsors (or total society benefits) which might still justify proceeding with the project.

In this generic example, the second method will be used in the net present worth analyses.

COST AND BENEFIT ASSUMPTIONS FOR THE RECYCLING ALTERNATIVE:

In order to determine the cost-effectiveness of the recycling alternative through a present worth analysis, all of the relevant costs and benefits must be identified, along with their timing. The savings in the cost of purchasing imported water is included as a benefit in the analyses along with any value placed on leaving the imported water in its natural source. In this example, the costs and the year in which they will occur have been assumed to be as shown in the following table:

Item	Year of Expenditure	Cost in Current Year Dollars
Capital Costs:		
Pumping Station	Years 0 and 1	$700,000
Distribution System	Years 0 through 2	$1,850,000
Retrofit Costs	Years 1 and 2	$150,000
Annual O&M Costs	Years 1 through 25	$68/AF pumping costs
Benefits:		
Fertilizer Value Of Nutrients (NO_3, PO_4, K)	Years 1 through 25	$10 per AF
Potable Water Cost Savings	Years 1 through 25	$325 per AF
Preservation of Environmental Values in Potable Water Source	Years 1 through 25	$15 per AF

Under this scenario, there could be a benefit assigned to the project equal to the savings in nitrification/denitrification costs for the portion of the flow delivered by the project, if the plant was so designed that a portion of the flow could avoid the nitrification/denitrification process. In a small plant, this is very unlikely so no benefit of avoided nitrification will accrue to the project. In fact, the fertilizer value will be reduced because about one-third of the nitrogen and all of the ammonia will have been removed in order for the remainder of the flow to meet discharge requirements. Even if it was possible to bypass the nitrification/denitrification process, there would be no capital cost savings because the entire flow would have to be treated for nitrate reduction in the winter months when the water is not needed for irrigation (unless the RWQCB exempts winter flows). Therefore, in order to avoid building two plants, the water delivered for irrigation would be the same as that discharged to the stream and there would be no treatment savings credit. In other situations, there might be such a credit and it should be considered in any similar analysis.

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PRESENT WORTH ANALYSIS:

The present worth analysis is carried out through preparation of a spreadsheet as shown in Table 3-1 for the 500 AFY example. The table was developed in the following manner:

Column A: ***Project Year***
In a normal table, the actual year that the project starts delivering water is entered at year 1 and the remaining years in the table are based on the period of time chosen for the evaluation. Generally, the time period should be as long as the expected life of the facilities or the expected amortization period for the bonds used to finance the project. Usually the time period is from 20 to 30 years after the delivery of reclaimed water begins. In this example, 25 years was selected as the period over which the present worth of the costs and benefits would be calculated. Year 0 is the year prior to deliveries when most of the construction will be accomplished. In this case, it is assumed that the construction of the pumping station and portions of the distribution system will be completed in year 0, with the remainder of the distribution system and the retrofits for the users completed in the first two years after operations begin.

Column B: ***Projected Recycled Water Sales***
In this column, the expected rate of deliveries of reclaimed water to customers is entered for each year. Most projects do not start at full capacity in the first year. Even for a small project like this example, it is assumed that full project capacity of 500 AFY will not be achieved until the third year of operation.

Column C: ***Design and Construction Costs***
All of the design, construction and retrofitting costs have been summed for each year and entered here. In this case, there were no costs for additional treatment facilities.

However, if there were, they would be included here and the total construction period might also be longer. If desired, each factor could be given its own column to facilitate keeping track of its impacts on cost effectiveness. Sometimes the life expectancy of various types of project facilities are different; for example, replacement costs for major pieces of mechanical equipment might be entered at 10 or 15 years, if appropriate. Replacement costs that occur before the end of the amortization period can also be handled by including a uniform sinking fund component in the fixed O&M figure.

Column D: ***Fixed Operation and Maintenance Costs***

Fixed O&M costs are those annual operating or maintenance costs which are not proportional to flow. In this case, the cost of operating and maintaining the system is represented by some labor, equipment and materials that are assumed to be furnished in-house by the agency (rather than by contracting for help from outside the agency) at an estimated uniform annual rate of $60,000 per year in current year dollars.

Column E: ***Variable Operation and Maintenance Costs***

Variable O&M costs are costs that are proportional to flow. In this case the primary cost is for power to pump the reclaimed water from the plant to the customers. The cost of $68 per AF was based on $0.10 per kWh for a 425-foot pumping head and the amount of water sold per year as indicated in column B.

Column F: ***Miscellaneous Benefits***

Miscellaneous benefits represent the sum of all assumed benefits, whether tangible or intangible, for which estimates must be made. In this case, benefits were assumed to be $10/AF (ammonia is converted to nitrate, but less than 10 mg/L total N, phosphates – PO_4 – and potassium, K) for the fertilizer value of the nutrients in the recycled water and $15/AF for the enhanced value to the source of the imported water. CALFED may develop better estimates of the value of reduced delta exports. There are no good rules for establishing the value of these benefits. In some irrigation settings where the reclaimed water is held in lakes for storage or aesthetic purposes, there may be an increased cost for chemicals or maintenance of the lakes that offsets the nutritional benefit. In others, the impact of increased salts from the reclaimed water may be detrimental to the golf course greens and require offsetting capital expenditures to modify them. Most people believe there is an environmental benefit associated with leaving more water in natural water courses, but there is difficulty in getting people to agree on its equivalent dollar value. The same is true for enhanced water supply reliability or enhanced community values because of the availability of reclaimed water for various uses or to maintain streams or aquatic features of the community. The basic rule is that the value of this benefit must be acceptable to the involved stakeholders who must approve the project.

Column G: ***Potable Water Savings***

The savings in the purchase of potable water by the LMWD is a clearly defined reduction in costs for the agency based on the price they pay for imported water—in this case, $325 per AF. Its inclusion at this point in the analysis results in a **net** unit cost for the reclaimed water. If this figure is omitted from the table, the table will yield the unit cost of producing and delivering the reclaimed water. That unit cost can then be compared to the cost of imported water. If the regional importing agency has already established an increasing price structure based on its need to develop new sources of water to import, the anticipated pricing structure should be included only to the extent that it exceeds the anticipated rate of inflation. If the regional importing agency has a subsidy program that reflects additional savings to it in power or avoidance of additional new source development, this figure can also be entered as a benefit in this portion of the table. Even if the amount of the subsidy does not represent all of the benefits to the regional agency, it reflects the amount the agency is willing to recognize as a beneficial saving.

Column H: ***Distribution System Savings***

In addition to purchasing the water from the regional importation agency, the LMWD must pay the costs for distributing the water in the community. The variable portion of that cost has been stipulated to be $186 per AF in this example.

Column I: ***Salvage Value***

The salvage value is entered at the end of the evaluation period. Since some facilities have a much longer useful life expectancy than others, the inclusion of salvage value allows a fairer comparison of alternative projects which have significantly different types of capital facilities. In this example, the distribution system has a projected life of 50 years and the pump station has a projected life of about 25 years. Therefore, the salvage value of the system is estimated to be about half of the cost of the distribution system or $925,000.

Column J: ***Present Worth Factor***

The present worth factor (PWF) is included in this column. As described elsewhere, it is based on an assumed discount interest rate and the number of years before the expenditure or benefit occurs. In this example, the discount interest rate was assumed to be 6 percent. The present worth factor for year zero is 1.0 and the PWF for negative years prior to year 0 will be greater than 1. The formula for the present worth factor is: 1/(1+i)^n, where "i" is the discount interest rate being used and n is the number of years after year zero.

Column K through P:

Columns K through P simply convert the costs and benefits listed in columns C through I into their present worth in year 1 (note that the fixed and variable O&M costs have been combined in column L) by multiplying them by the present worth factor contained in Column J.

Column Q: ***Net Present Worth***

The Net Present Worth is the sum of the present worth costs (Columns K and L) minus the sum of the present worth of the benefits (Columns M through P). The results are totaled at the bottom of the table.

Column R: ***Present Worth of Water Sales***

In this column, the present worth factor from Column J has been multiplied by the quantity of reclaimed water listed in Column B to generate a reduced volume of water sales that some (in particular, the SWRCB) feel is the appropriate amount of water to use when developing unit costs by the present worth method. Since the dollars have been discounted back to year 0, the quantities have been similarly discounted. Others (including CUWA) favor using the actual quantities as totaled for Column B when determining unit costs. As shown in the unit cost calculations at the bottom of the sheet, the division of the present worth costs by the actual quantity of water results in a lower apparent unit cost than that obtained using the present worth calculation of quantity from Column R. CUWA recommends using the total quantity of projected recycled water usage in the calculation of unit cost, but the method used by the SWRCB is included herein to assist a sponsor seeking a State loan or grant. The essential difference between the two methods of calculating unit costs of water is that the CUWA method represents the unit costs if an agency were able to invest enough funds at year zero to pay all of the costs of the project for 25 years. Whereas, the SWRCB method more nearly represents the average unit cost of water that will be paid each year as the water is produced.

Unit Costs

The net unit costs, which represent the *additional* cost per unit of water for the recycled water as compared to the "no project" alternative, are presented in two ways at the bottom of the sheet. The first number, $27 per AF, is obtained by dividing the net present worth of the costs minus the value of the benefits by the total actual water to be sold over 25 years as shown in column B. This is the method favored by CUWA. The second unit cost of $52 per AF is derived by dividing the Net Present Worth of costs minus benefits by the present worth of water sales as shown in column R. This is the method to be used if applying for a State loan or grant. By the CUWA method, the unit cost of the reclaimed water over the life of the project is projected to be $27 per AF more than the value of the identified benefits.

In analyzing this alternative, the sponsoring agency must consider whether there are other benefits that ought to be included explicitly in the table or whether there are other, intangible arguments that would make the project worth the additional $27 per AF beyond the cost of continuing with the existing water supply system. Issues worth further consideration include the possibility that the existing supply may be interrupted by water rights or environmental issues, the perceived greater reliability/availability of recycled water, community pride, or some other intangible factor which could cause the sponsoring agency to proceed with the project in spite of the projected costs or seek ways to quantify other intangible benefits or modify the size or characteristics of the project in order to make it economically attractive.

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Table 3-1

EXAMPLE OF AN ECONOMIC ANALYSIS FOR A SMALL WATER RECLAMATION PROJECT

Hypothetical Small Project: Ultimate Capacity of 500 AFY for Irrigation of Parks, School Grounds and Land Scaping (Alternative "500-a")

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
		Costs			Benefits					Present Worth of costs, $		Present Worth of Benefits, $					
			O&M costs, $														
Year of project	AF/yr sold /a/	Design & Construction cost	Fixed	Variable /b/	Misc. Benefits $ /c/	Potable Water Savings $ /d/	Dist. System Savings $ /e/	Salvage value, $ /f/	Present worth factor @ 6% Int.	Constr & replacement cost	O&M	Misc. Benefits credit	Water Savings Credit	Dist. System Savings	Salvage	Net Present Worth of Costs minus Benefits $	Present Worth of water sales AF
0		400,000	0	0	0	0	0		1.000000	400,000	0	0	0	0		400,000	0
1	150	1,550,000	60,000	10,200	3,750	48,750	27,900		0.943396	1,462,264	66,226	3,538	45,991	26,321		1,452,642	142
2	250	700,000	60,000	17,000	6,250	81,250	46,500		0.889996	622,998	68,530	5,562	72,312	41,385		572,268	222
3	500		60,000	34,000	12,500	162,500	93,000		0.839619	0	78,924	10,495	136,438	78,085		(146,094)	420
4	500		60,000	34,000	12,500	162,500	93,000		0.792094	0	74,457	9,901	128,715	73,665		(137,824)	396
5	500		60,000	34,000	12,500	162,500	93,000		0.747258	0	70,242	9,341	121,429	69,495		(130,023)	374
6	500		60,000	34,000	12,500	162,500	93,000		0.704961	0	66,266	8,812	114,556	65,561		(122,663)	352
7	500		60,000	34,000	12,500	162,500	93,000		0.665057	0	62,515	8,313	108,072	61,850		(115,720)	333
8	500		60,000	34,000	12,500	162,500	93,000		0.627412	0	58,977	7,843	101,955	58,349		(109,170)	314
9	500		60,000	34,000	12,500	162,500	93,000		0.591898	0	55,638	7,399	96,184	55,047		(102,990)	296
10	500		60,000	34,000	12,500	162,500	93,000		0.558395	0	52,489	6,980	90,739	51,931		(97,161)	279
11	500		60,000	34,000	12,500	162,500	93,000		0.526788	0	49,518	6,585	85,603	48,991		(91,661)	263
12	500		60,000	34,000	12,500	162,500	93,000		0.496969	0	46,715	6,212	80,758	46,218		(86,473)	248
13	500		60,000	34,000	12,500	162,500	93,000		0.468839	0	44,071	5,860	76,186	43,602		(81,578)	234
14	500		60,000	34,000	12,500	162,500	93,000		0.442301	0	41,576	5,529	71,874	41,134		(76,960)	221
15	500		60,000	34,000	12,500	162,500	93,000		0.417265	0	39,223	5,216	67,806	38,806		(72,604)	209
16	500		60,000	34,000	12,500	162,500	93,000		0.393646	0	37,003	4,921	63,968	36,609		(68,494)	197
17	500		60,000	34,000	12,500	162,500	93,000		0.371364	0	34,908	4,642	60,347	34,537		(64,617)	186
18	500		60,000	34,000	12,500	162,500	93,000		0.350344	0	32,932	4,379	56,931	32,582		(60,960)	175
19	500		60,000	34,000	12,500	162,500	93,000		0.330513	0	31,068	4,131	53,708	30,738		(57,509)	165
20	500		60,000	34,000	12,500	162,500	93,000		0.311805	0	29,310	3,898	50,668	28,998		(54,254)	156
21	500		60,000	34,000	12,500	162,500	93,000		0.294155	0	27,651	3,677	47,800	27,356		(51,183)	147
22	500		60,000	34,000	12,500	162,500	93,000		0.277505	0	26,085	3,469	45,095	25,808		(48,286)	139
23	500		60,000	34,000	12,500	162,500	93,000		0.261797	0	24,609	3,272	42,542	24,347		(45,553)	131
24	500		60,000	34,000	12,500	162,500	93,000		0.246979	0	23,216	3,087	40,134	22,969		(42,974)	123
25	500		60,000	34,000	12,500	162,500	93,000	925,000	0.232999	0	21,902	2,912	37,862	21,669	215,524	(256,065)	116
Total	11,900	2,650,000	1,500,000	809,200	297,500	3,867,500	2,213,400	925,000		2,485,262	1,164,053	145,975	1,897,672	1,086,052	215,524	304,092	5,839

Unit Cost = $26 /AF, based on actual acre-feet of water sold over 25 years; $52 /AF, based on Present Worth Calculation of Quantity

/a/ Based on anticipated rates at which users will connect to the system.

/b/ Based on pumping costs of $ 68/AF for 425 feet of head.

/c/ Based on $1O/AF for irrigation fertilizer value, (N < 10 mg/L), and $15/AF for reduction of source stream impacts.

/d/ Based on $ 325 /AF; the price that LMWD pays for imported potable water.

/e/ Based on $ 186 /AF for operation of the potable water distribution system.

/f/ Based on useful lives of 25 years for pump stations, 50 years for force mains and distribution pipelines.

/b/ All costs adjusted to midpoint of construction. Includes costs for pumping station, distribution system and retrofitting.

The Medium Sized Project
5,000/7,500 AF/Y

ASSUMPTIONS

- The wastewater treatment agency is a Sanitary District with a 20 mgd secondary treatment plant discharging unnitrified effluent to the ocean through an outfall. The water supply agency is a Municipal Water District with 25 percent of its supply derived from groundwater and the rest imported through a regional agency. The population served is 235,000 and the average per capita water usage is 165 gallons per day for a total current water demand of 43,400 AFY. There are two major industries in the community, a paper manufacturing plant with a demand for 2 mgd of process water and a power generating facility with a demand for 1.5 mgd of cooling water. In addition, there are several golf courses, parks, schoolyards, two nurseries, a cemetery, and freeway landscaping with a total demand of 1,500 AFY. The initial project will be for 5,000 AFY with a projected increase to 7,500 AFY in the tenth year of operation to accommodate growth and serve more irrigation and industrial users.
- The two industrial users can receive the recycled water continuously, generally at constant flow rates, 24-hours per day. The irrigation uses will be limited to applications during nighttime hours between 9:00 p.m. and 6:00 a.m.
- The irrigation and paper industry uses can be supplied with Title 22, <2.2 MPN, water, but the water to be used by the power plant must also have the ammonia converted to nitrate or removed in order to protect the coils in the cooling tower from corrosion.
- The community is growing and the population is expected to increase 20 percent in the next 10 years (assume 2 percent per year). The groundwater supply is being overdrafted and must be reduced by 25 percent to stabilize withdrawals at the estimated safe yield of the basin (assume reduction occurs in the year the reclamation project starts operation). This means that more potable water must be imported unless recycling can make up the difference in projected demand.
- The current price of groundwater is $125 per acre-ft. The current price of imported water is $535 per acre-ft and costs are expected to increase at the rate of 5 percent per year above the inflation rate for the next 10 years to cover the costs of new capital facilities by the regional importation agency.
- There are unidentified and intangible environmental impacts on the river and lake system from which the region imports its potable water; they have been valued at $10 per AF.
- There is a perceived benefit associated with reducing the discharge of wastewater to the ocean environment that has been valued at $5 per AF.
- Present worth costs will be compared based on 25 years of water deliveries and a discount interest rate of 6 percent.

ALTERNATIVES:

1. **No Project Alternative:** Do not build the recycling project and increase the amount of imported water as necessary to meet project demand.
2. **Recycling Alternative:** Implement the maximum amount of reuse currently available and expand when opportunities present themselves as the population increases.

PRESENT WORTH COMPARISON:

For this example, the comparison of the alternatives will be conducted by the **first method** described on page 3-24, each alternative will be analyzed independently of the other to determine a unit cost of providing the 5,000/7,500 AFY of water to the identified users. The savings in water purchases will therefore not be treated as a benefit of the recycling alternative as it was in the small project example. In this example, the costs and the year in which they will occur have been assumed to be as shown in the following tables:

Alternative A: No Project

Item	Years of Expenditure	Cost in Current Year Dollars
Costs:		
Potable Water Costs	Years 1 through 25	$535 per AF [1]
Environmental Degradation of Potable Water source	Years 1 through 25	$5 per AF

[1] For imported water, but it increases with time per assumptions.

Alternative B: Recycling Project

Item	Year of Expenditure	Cost in Current Year Dollars
Costs:		
Tertiary Treatment Plant	Years -2 through +2	$10,000,000 for 5,000 AFY
Ammonia Removal Facility	Years 1 and 2	$3,000,000 for 1,500 AFY
Distribution System	Years -1 through 1	$12,000,000
System Expansion	Years 9 and 10	$8,000,000
Retrofit Costs	Years 0, 1, 2, and 10	$1,400,000
Benefits:		
Enhancement of the Ocean Environment	Years 1 through 25	$5/AF

DRAFT

PRESENT WORTH ANALYSIS:

The present worth analysis is carried out through preparation of a spreadsheet for each alternative as shown in Table 3-2, for the "No Project" alternative, and Table 3-3 for the recycling alternative.

Present Worth Analysis of Alternative A - No Project

Table 3-2 was developed in the following manner:

Column A: ***Project Year***
Year zero is the year before the project begins operating. The evaluation period is arbitrarily set at 25 years.

Column B: ***AFY Sold***
This is the anticipated water potable water demand that would be replaced by the proposed recycled water project.

Column C through F: Costs

These are the four cost categories for the "no project" alternative. There is no capital cost because the importation system exists and the cost does not change with the amount of water imported. Column C is the price paid to the regional importing agency for the water. It includes an escalation in the rate of 5 percent per year for the first 10 years. The regional agency will have build capital facilities to increase its supply and make up for both the population growth and the reduction in groundwater available to the community. However, the LMWD sees this as an escalating price for its imported water. The price starts at $535 per AF, but after 10 years it reaches $915 per AF in 0-year dollars.

Column D represents the negative impact of removing the imported water from its source, estimated at $15 per AF.

Columns E & F represent O&M costs. In this case, no fixed O&M costs were identified that would not occur if this water is not imported. However, the LMWD chlorinates the imported water at a cost of $15/AF, which is entered as a variable cost since it is proportional to flow.

Column G and H: Benefits

No benefits were identified for this alternative and there is no salvage value because there were no capital expenses incurred.

Column I ***Present Worth Factor***
The present worth factors are based on a 6 percent discount interest rate.

Column J through L: Present Worth of Costs
These columns are obtained by multiplying the cost columns, C, D and F, by the Present Worth Factor in Column I.

Column M and N: Present Worth of Benefits
There are no benefits in this example, but the columns are shown to illustrate where they would fall if there were any benefits identified.

Column O: ***Net Present Worth of Costs minus Benefits***
This is the sum of Columns J, K and L, minus the sum of Columns M and N. It represents the value of each year's projected costs in year zero.

Column P: ***Present Worth of Water Sales***
See the description under the Small Project Example.

Present Worth Analysis of Alternative B - Recycling:

Table 3-3 was developed in the following manner:

Column A: ***Year of Project***
Since this is a much larger project, there are capital costs incurred for several years prior to the commencement of its operation. By convention, year zero is the year prior to operation, so the years prior to year zero are given negative numbers.

Column B: ***AFY sold***
This is the anticipated rate at which recycled water will be sold. It is the same schedule used in the "No Project" alternative.

Column C: ***Design and Construction Cost***
These include all capital costs of the project and the estimated year in which they will be spent. Costs include the tertiary treatment facilities, nitrification facilities, storage facilities, distribution pipelines and retrofitting the plumbing of users.

Column D: ***Fixed O&M costs***
Fixed O&M costs are those operational and maintenance costs which occur regardless of the amount of recycled water sold. In this example, they were set at $780,000 for the 5,000 AFY facility and increased to $1,200,000 per year when the system is expanded to 7,500 AFY. It includes all labor, monitoring, repairs, minor replacement costs and any other items not used in proportion to flow.

Column E: ***Variable O&M Costs***
The variable costs tend to be comprised of Power and Chemicals which are generally used in proportion to flow.

Column F: ***Miscellaneous Benefits***
The only identified benefit that is not related to reductions in importation of potable water are related to the perceived improvement to the ocean environment of reducing the wastewater discharge, estimated here at $5/AF.

Column G: ***Potable Water Savings***
In this type of economic comparison of two alternatives, the No Project alternative accounts for the saving in imported water costs. To include it here would be double accounting. However, the column was left in for comparison with the other method of conducting an economic analysis as shown in the small project example.

Column H: ***Salvage Value***
The salvage value is based on straight-line depreciation of capital costs with the expected life of treatment facilities estimated at 25 years and the distribution system at 50 years. The salvage value represents the remaining life of the distribution system and part of the treatment facilities built in year 10.

Column I: ***Present Worth Factor***
The present worth factors are based on a 6 percent discount interest rate. See Section 3.4 for more detailed explanation.

Column J through N: Present Worth Costs and Benefits
As in the previous tables, these columns convert the values in Columns C through H into their equivalent present worth by multiplying them by the factors in Column I.

Column O: ***Net Present Worth of Costs minus Benefits***
This is the sum of Columns J and K minus the sum of Columns L, M and N. It represents the value of each years projected costs in year zero.

Column P: ***Present Worth of Water Sales***
See the description under the Small Project Example.

COMPARISON OF PROJECT ALTERNATIVES

Unit Costs:

On the bottom line of both Tables 3-2 and 3-3, unit costs for the water over the life of the project are presented in two different formats. As explained in the discussion of Unit Costs under the Small Project Present Worth Analysis, the first method (favored by CUWA) divides the total Present Worth by the actual amount of water to be used over 25 years and the second method (favored by the SWRCB) divides the Total Present Worth by the Present Worth of the water quantity is contained in Column P. However, in this comparison the unit costs relate to the estimated cost of the water and not the net difference in costs, as calculated for the Small Project.

Table 3-2

EXAMPLE OF AN ECONOMIC ANALYSIS FOR THE "NO PROJECT" ALTERNATIVE TO A MEDIUM SIZED WATER RECLAMATION PROJECT

9/11/98

Hypothetical Medium Sized Project: Initial Capacity of 5,000 AFY for Irrigation and industrial uses, expanding to 7,500 AFY after 10 years

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
		Costs				Benefits			Present Worth of costs, $			Present Worth of Benefits, $			
				O&M costs, $											
Year of project	AF/yr sold /a/	Imported Potable Water Supply ($) /b/	Impacts on Water Source $ /c/	Fixed	Variable /d/	Misc. Benefits $	Salvage value, $ /e/	Present worth factor @ 6% int.	Purchase of Potable water	Impacts on water Source	Variable O&M Costs	Misc. Benefits	Salvage value	Net Present Worth of Costs minus Benefits $	Present Worth of water sales AF
0						0		1.000000	0	0	0	0	0	0	0
1	1,200	642,000	18,000	0	18,000	0		0.943396	605,660	16,981	16,981	0	0	639,623	1,132
2	3,200	1,797,600	48,000	0	48,000	0		0.889996	1,599,858	42,720	42,720	0	0	1,685,297	2,848
3	5,000	2,949,188	75,000	0	75,000	0		0.839619	2,476,195	62,971	62,971	0	0	2,602,138	4,198
4	5,000	3,096,647	75,000	0	75,000	0		0.792094	2,452,834	59,407	59,407	0	0	2,571,648	3,960
5	5,000	3,251,479	75,000	0	75,000	0		0.747258	2,429,694	56,044	56,044	0	0	2,541,783	3,736
6	5,000	3,414,053	75,000	0	75,000	0		0.704961	2,406,773	52,872	52,872	0	0	2,512,517	3,525
7	5,000	3,584,756	75,000	0	75,000	0		0.665057	2,384,067	49,879	49,879	0	0	2,483,826	3,325
8	5,000	3,763,994	75,000	0	75,000	0		0.627412	2,361,576	47,056	47,056	0	0	2,455,688	3,137
9	5,000	3,952,193	75,000	0	75,000	0		0.591898	2,339,297	44,392	44,392	0	0	2,428,082	2,959
10	6,000	4,979,764	90,000	0	90,000	0		0.558395	2,780,674	50,256	50,256	0	0	2,881,185	3,350
11	6,500	5,664,481	97,500	0	97,500	0		0.526788	2,983,978	51,362	51,362	0	0	3,086,702	3,424
12	7,500	6,862,737	112,500	0	112,500	0		0.496969	3,410,570	55,909	55,909	0	0	3,522,388	3,727
13	7,500	6,862,737	112,500	0	112,500	0		0.468839	3,217,519	52,744	52,744	0	0	3,323,008	3,516
14	7,500	6,862,737	112,500	0	112,500	0		0.442301	3,035,395	49,759	49,759	0	0	3,134,913	3,317
15	7,500	6,862,737	112,500	0	112,500	0		0.417265	2,863,580	46,942	46,942	0	0	2,957,465	3,129
16	7,500	6,862,737	112,500	0	112,500	0		0.393646	2,701,491	44,285	44,285	0	0	2,790,061	2,952
17	7,500	6,862,737	112,500	0	112,500	0		0.371364	2,548,576	41,778	41,778	0	0	2,632,133	2,785
18	7,500	6,862,737	112,500	0	112,500	0		0.350344	2,404,317	39,414	39,414	0	0	2,483,145	2,628
19	7,500	6,862,737	112,500	0	112,500	0		0.330513	2,268,224	37,183	37,183	0	0	2,342,589	2,479
20	7,500	6,862,737	112,500	0	112,500	0		0.311805	2,139,834	35,078	35,078	0	0	2,209,990	2,339
21	7,500	6,862,737	112,500	0	112,500	0		0.294155	2,018,711	33,092	33,092	0	0	2,084,896	2,206
22	7,500	6,862,737	112,500	0	112,500	0		0.277505	1,904,444	31,219	31,219	0	0	1,966,883	2,081
23	7,500	6,862,737	112,500	0	112,500	0		0.261797	1,796,646	29,452	29,452	0	0	1,855,550	1,963
24	7,500	6,862,737	112,500	0	112,500	0		0.246979	1,694,949	27,785	27,785	0	0	1,750,519	1,852
25	7,500	6,862,737	112,500	0	112,500	0	0	0.232999	1,599,008	26,212	26,212	0	0	1,651,433	1,747
Total	156,900	133,174,468	2,353,500	0	2,353,500	0	0		58,423,871	1,084,795	1,084,795	0	0	60,593,460	72,320

Unit Cost = $386 /AF, based on actual acre-feet of water sold over 25 years; $838 /AF, based on Present Worth Calculation of Quantity

/a/ Based on anticipated rates at which users will connect to the system.

/b/ All costs adjusted to midpoint of construction. Includes costs for pumping station, distribution system and retrofitting.

/c/ Based on $15/AF for the benefits of leaving the equivalent amount of reclaimed water in the source water body.

/d/ Based on $ 15/AF for chlorination.

/e/ Since no capital costs were identified for this alternative, there is no salvage value.

/f/ Based on $ 535 per AF; the price paid by the LMWD to the importing agency for potable water.

Table 3-3

EXAMPLE OF AN ECONOMIC ANALYSIS FOR A MEDIUM SIZED WATER RECLAMATION PROJECT

Hypothetical Medium Sized Project: Initial Capacity of 5,000 AFY for Irrigation and industrial uses, expanding to 7,500 AFY after 10 years

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
		Costs			Benefits				Present Worth of costs, $		Present Worth of Benefits, $				
Year of project	AF/yr sold /a/	Design & Construction cost /b/	O&M costs, $ Fixed	O&M costs, $ Variable /d/	Misc. Benefits $ /c/	Potable Water Savings $ /f/	Salvage value, $ /e/	Present worth factor @ 6% int.	Constr & replacement cost	O&M	Misc. Benefits	Water Savings Credit	Salvage value	Net Present Worth of Costs minus Benefits $	Present Worth of water sales AF
-2		1,200,000		0	0			1.123600	1,348,320	0	0	0	0	1,348,320	0
-1		6,600,000			0	0		1.060000	6,996,000	0	0	0	0	6,996,000	0
0		12,000,000			0	0		1.000000	12,000,000	0	0	0	0	12,000,000	0
1	1,200	4,600,000	780,000	156,000	6,000	0		0.943396	4,339,623	883,019	5,660	0	0	5,216,981	1,132
2	3,200	1,500,000	780,000	416,000	16,000	0		0.889996	1,334,995	1,064,436	14,240	0	0	2,385,190	2,848
3	5,000		780,000	815,000	25,000	0		0.839619	0	1,339,193	20,990	0	0	1,318,202	4,198
4	5,000		780,000	815,000	25,000	0		0.792094	0	1,263,389	19,802	0	0	1,243,587	3,960
5	5,000		780,000	815,000	25,000	0		0.747258	0	1,191,877	18,681	0	0	1,173,195	3,736
6	5,000		780,000	815,000	25,000	0		0.704961	0	1,124,412	17,624	0	0	1,106,788	3,525
7	5,000		780,000	815,000	25,000	0		0.665057	0	1,060,766	16,626	0	0	1,044,140	3,325
8	5,000		780,000	815,000	25,000	0		0.627412	0	1,000,723	15,685	0	0	985,037	3,137
9	5,000	3,000,000	780,000	815,000	25,000	0		0.591898	1,775,695	944,078	14,797	0	0	2,704,976	2,959
10	6,000	5,500,000	780,000	945,000	30,000	0		0.558395	3,071,171	963,231	16,752	0	0	4,017,650	3,350
11	6,500		1,200,000	1,010,000	32,500	0		0.526788	0	1,164,200	17,121	0	0	1,147,080	3,424
12	7,500		1,200,000	1,140,000	37,500	0		0.496969	0	1,162,908	18,636	0	0	1,144,272	3,727
13	7,500		1,200,000	1,140,000	37,500	0		0.468839	0	1,097,083	17,581	0	0	1,079,502	3,516
14	7,500		1,200,000	1,140,000	37,500	0		0.442301	0	1,034,984	16,586	0	0	1,018,398	3,317
15	7,500		1,200,000	1,140,000	37,500	0		0.417265	0	976,400	15,647	0	0	960,753	3,129
16	7,500		1,200,000	1,140,000	37,500	0		0.393646	0	921,132	14,762	0	0	906,371	2,952
17	7,500		1,200,000	1,140,000	37,500	0		0.371364	0	868,993	13,926	0	0	855,067	2,785
18	7,500		1,200,000	1,140,000	37,500	0		0.350344	0	819,804	13,138	0	0	806,667	2,628
19	7,500		1,200,000	1,140,000	37,500	0		0.330513	0	773,400	12,394	0	0	761,006	2,479
20	7,500		1,200,000	1,140,000	37,500	0		0.311805	0	729,623	11,693	0	0	717,930	2,339
21	7,500		1,200,000	1,140,000	37,500	0		0.294155	0	688,324	11,031	0	0	677,293	2,206
22	7,500		1,200,000	1,140,000	37,500	0		0.277505	0	649,362	10,406	0	0	638,955	2,081
23	7,500		1,200,000	1,140,000	37,500	0		0.261797	0	612,606	9,817	0	0	602,788	1,963
24	7,500		1,200,000	1,140,000	37,500	0		0.246979	0	577,930	9,262	0	0	568,668	1,852
25	7,500		1,200,000	1,140,000	37,500	0	8,000,000	0.232999	0	545,217	8,737	0	1,863,989	(1,327,510)	1,747
Total	156,900	34,400,000	25,800,000	24,192,000	784,500	0	8,000,000		30,865,804	23,457,091	361,598	0	1,863,989	52,097,307	72,320

Unit Cost = $332 /AF, based on actual acre-feet of water sold over 25 years; $720 /AF, based on Present Worth Calculation of Quantity

/a/ Based on anticipated rates at which users will connect to the system.

/b/ All costs adjusted to midpoint of construction. Includes costs for pumping station, distribution system and retrofitting.

/c/ Based on $5/AF for the benefit of removing the equivalent amount of wastewater discharge to the ocean.

/d/ Based on $ 130/AF for Title 22 processes and pumping costs and $110/AF for 1,500 AFY of nitrification starting in year 3.

/e/ Based on useful lives of 25 years for pump stations and treatment facilities and 50 years for force mains and distribution pipelines.

/f/ Based on $ 535 per AF; the price paid by the LMWD to the importing agency for potable water.

By using separate spreadsheets for each alternative, the projects are compared by looking at the unit cost of the No Project alternative ($386/AF by the CUWA method and $838/AF by the SWRCB method) and comparing them with the unit costs for the Recycling Project alternative ($332/AF by the CUWA method and $720/AF by the SWRCB method). For this example, the Recycling project is lower in cost ($54/AF less by the CUWA method and $118 less by the SWRCB method) and therefore requires no further justification on the basis of intangible values.

If the results had been in the other direction (the no project alternative having lower unit costs), the sponsoring agency would have to consider whether there are other benefits that ought to be included explicitly in the table or whether there are other, intangible arguments that would make the project worth the additional cost. Issues worth further consideration include the possibility that the existing supply may be interrupted by water rights or environmental issues, the perceived greater reliability/availability of recycled water, community pride, or some other intangible factor. These intangible factors could cause the sponsoring agency to proceed with the project in spite of the projected costs or seek ways to quantify other intangible benefits or modify the size or characteristics of the project in order to make it economically attractive.

DRAFT

KEY REFERENCES AND AGENCY CONTACTS

1) California Urban Water Agencies, "Guidelines to Conduct Cost-Effective Best Management Practices for Urban Water Conservation," 1996

2) United States Environmental Protection Agency, "Cost-Effectiveness Analysis Guidelines," 40 CFR Part 35, Support E, Appendix A.

3) State Water Resources Control Board, Division of Clean Water Programs, "Financial Assistance Application and Water Recycling Funding Guidelines," (contact Lynn E. Johnson; 916/227-4580)

4) United States Bureau of Reclamation, "Preparing Reviewing and Processing Proposed Water Reclamation and Reuse Projects Under Title XVI of P.L. 102-575 (contact Rick Martin: 202/208-3965 or 909/695-5310)

Section 4

DEVELOPING A FINANCING PLAN

Having established the cost-effectiveness of a proposed recycled water project, a key component of a feasibility report is the development of the financing plan (i.e., the determination of who pays what portion of the total costs and how they pay). For example, a project may be cost-effective but may not be financially feasible without significant outside funding contributions. Thus, financial feasibility is typically a critical issue to Boards of Directors and other policy makers in determining whether to implement a project.

The implementation of a recycled water project involves a substantial up-front capital investment for planning studies, environmental impact reports, engineering design and construction before there is any product to sell. Most projects will involve the issuance of revenue bonds or other long-term debt instruments such as certificates of participation (COPs) to spread the up-front capital costs over a 20 to 30 year period. In order to sell revenue bonds (or COPs) at reasonable interest rates, the project sponsor must show that there will be sufficient revenue over the life of the project to repay the bonds with interest, as well as cover the annual operating, maintenance, and administration costs of the project.

Another financial issue with a water recycling project is the lag time in connecting customers during the initial few years and insufficient recycled water sales revenue to cover project expenditures. A financing plan identifies the bonding or capital sources available and forecasts potential revenues from water and recycled water sales, taxes, and other revenues that in combination will cover the project annual operating costs and debt payments.

This financing section will provide general guidance on how to prepare a cash flow analysis and a financial plan for a project. In addition, opportunities to minimize cash outlays and increase revenues are discussed.

In determining financial feasibility, much of the cost information required has been developed in conducting the cost-effectiveness analysis discussed in Section 3. What differs is the inclusion of revenue sources in a financial cash flow analysis. In a financial cash flow analysis, the components of a project's cost and revenues are estimated in a financial spreadsheet. In essence, a multi-year budget is prepared of all costs expended each year and revenues received in each year to determine if revenues are sufficient to cover the costs in any year and over time and whether revenues are sufficient to cover expected expenditures.

The following are some of the typical categories of water recycling project expenses and revenues that should be included in building a project cash flow:

Costs

Capital Debt Service or one-time capital expenses

- Potential Land Acquisition
- Tertiary Treatment Facility
- Collection System
- Distribution System
- Permitting/Environmental Process

Operations and Maintenance

Tertiary Treatment

- Electrical Power
- Chemicals
- Replacement Parts
- Labor

Distribution and Collection

- Replacement Parts
- Labor
- Pumping
- Electrical Power
- Personnel and Administration
- Down Time
- Depreciation and Future Replacement Costs

Revenues

- RW Water Rates and Charges
- Potable Water Revenues

- Financial Incentives from Other Agencies (i.e., MWD LPP payments)
- State Low Interest Loans and USBR Grants
- Capacity Charges
- Connection Fees
- Tax Revenue
- Other

Cash Flow Analysis

Typical financial spreadsheet analyses are presented on Tables 4-1 and 4-2. In these analyses, there is no conversion of costs to a Present Worth. The purpose is to predict the cash demands or net income that the project will produce in each year of its 25 year life. In effect, this is a multi-year budget of future expenditures and revenues. All of the costs are identified, estimated and totaled. The Net Annual Balance is the Total Revenue minus Total Annual Expenses. In the final column, the Net Cumulative Balance identifies the cash flow position of the projects. (NOTE: the Cumulative Net Balance includes an unstated expense or income change based on 5 percent of the previous year's Net Cumulative Balance, which assumes the deficit must be funded from some other source).

The Small Project Financial Analysis (500 AF/Y)

Table 4-1 is a simplified cash flow for a retail purveyor for the 500 AF/Y project analyzed in Section 3. The estimated capital cost for this project is approximately $3 million with a total annual O&M cost of approximately $100,000 or $250 per acre-foot for treatment and distribution. In the example, the capital cost is debt financed through low interest SWRCB loans at 3 percent interest over 20 years. The revenue is the retail rate charged to the recycled water customers and a financial rebate from the wholesale water agency. In this example, it can be seen that the project is operating on a positive net annual cash flow basis by the third year and has recovered its cumulative costs (net cumulative balance) by year five of project operation. After three years, the project is projected to have a positive cash flow, but the Net Cumulative Balance does not reach the black until the 3rd or 5th year. The problem faced by most agencies is how to finance the early years of negative cash flow, even though the net balance will accumulate to a positive cash flow at the end of 25 years. Some form of debt must usually be incurred.

Table 4-1
Financial Cash Flow Analysis
500 AFY Small Project

FY Ends	Sales[1] AFY	Annual Project Costs			Annual Project Revenue			Annual Net Balance	Cumul. Net Balance
		O&M	Debt[2] Service	Total Costs	R/W Sales Revenue	Rebate[3]	Total Revenue		
2000	250	$109,582	$201,647	$311,229	$135,875	$62,500	$198,375	-$112,854	-$112,854
2001	375	$113,966	$201,647	$315,613	$214,003	$93,750	$307,753	-$7,860	-$120,714
2002	500	$118,524	$201,647	$320,171	$285,338	$125,000	$410,338	$90,167	-$30,547
2003	500	$123,265	$201,647	$324,912	$285,338	$125,000	$410,338	$85,426	$54,878
2004	500	$128,196	$201,647	$329,843	$285,338	$125,000	$410,338	$80,495	$135,373
2005	500	$133,324	$201,647	$334,971	$285,338	$125,000	$410,338	$75,367	$210,739
2006	500	$138,657	$201,647	$340,304	$285,338	$125,000	$410,338	$70,034	$280,773
2007	500	$144,203	$201,647	$345,850	$285,338	$125,000	$410,338	$64,488	$345,260
2008	500	$149,971	$201,647	$351,618	$285,338	$125,000	$410,338	$58,720	$403,980
2009	500	$155,970	$201,647	$357,617	$285,338	$125,000	$410,338	$52,721	$456,700
2010	500	$162,209	$201,647	$363,856	$285,338	$125,000	$410,338	$46,482	$503,182
2011	500	$168,697	$201,647	$370,344	$285,338	$125,000	$410,338	$39,994	$543,175
2012	500	$175,445	$201,647	$377,092	$285,338	$125,000	$410,338	$33,246	$576,421
2013	500	$182,463	$201,647	$384,110	$285,338	$125,000	$410,338	$26,228	$602,648
2014	500	$189,761	$201,647	$391,408	$285,338	$125,000	$410,338	$18,930	$621,578
2015	500	$197,352	$201,647	$398,999	$285,338	$125,000	$410,338	$11,339	$632,916
2016	500	$205,246	$201,647	$406,893	$285,338	$125,000	$410,338	$3,445	$636,361
2017	500	$213,455	$201,647	$415,102	$285,338	$125,000	$410,338	-$4,765	$631,596
2018	500	$221,994	$201,647	$423,641	$285,338	$125,000	$410,338	-$13,304	$618,293
2019	500	$230,873	$201,647	$432,520	$285,338	$125,000	$410,338	-$22,183	$596,110
2020	500	$240,108	$201,647	$441,755	$285,338	$125,000	$410,338	-$31,418	$564,693
2021	500	$249,713	$0	$249,713	$285,338	$125,000	$410,338	$160,625	$725,317
Totals:	10,625	$3,752,974	$4,234,587	$7,987,561	$6,056,628	$2,656,250	$8,712,878	$725,317	$725,317

[1] Market demand 50 percent in year 2000, 75 percent in 2001, and 100 percent thereafter.
[2] Assumes low interest low @ 3 percent.
[3] Assumes $250/AF Regional Agency Rebate

The Medium-Sized Project Financial Analysis (5,000 AF/Y)

The medium-sized recycled water project is a distribution system only project and the financial spreadsheet is shown on Table 4-2. The financing scenarios were based upon a utility's three-tier rate structure. The recycled water rates within the utility are identical to the adopted three-tier potable rates minus 20 percent. Recycled water use within the utility was proportioned based on market survey data from customer interviews.

- First Tier 7 percent
- Second Tier 41 percent
- Third Tier 52 percent

Table 4-2
Financial Cash Flow Analysis
5,000 AFY Medium Sized Project

FY Ends	Sales[1] AFY	Annual Project Costs			Annual Project Revenue			Annual Net Balance	Cumul. Net Balance
		O&M	Debt [2] Service	Total Costs	R/W Sales[3] Revenue	Rebate[4]	Total Revenue		
2000	0	$0	$0	$0	$0	$0	$0	$0	$0
2001	1,000	$150,000	$2,033,980	$2,183,980	$494,100	$150,000	$644,100	-$1,539,880	-$1,539,880
2002	2,000	$300,000	$2,033,980	$2,333,980	$1,022,580	$300,000	$1,322,580	-$1,011,400	-$2,551,280
2003	3,000	$450,000	$2,033,980	$2,483,980	$1,588,950	$450,000	$2,038,950	-$445,030	-$2,996,310
2004	4,000	$600,000	$2,033,980	$2,633,980	$2,192,040	$600,000	$2,792,040	$158,060	-$2,838,250
2005	5,000	$750,000	$2,033,980	$2,783,980	$2,836,800	$750,000	$3,586,800	$802,820	-$2,035,430
2006	5,000	$750,000	$2,033,980	$2,783,980	$2,922,116	$750,000	$3,672,116	$888,136	-$1,147,294
2007	5,000	$750,000	$2,033,980	$2,783,980	$3,012,386	$750,000	$3,762,386	$978,406	-$168,888
2008	5,000	$750,000	$2,033,980	$2,783,980	$3,102,655	$750,000	$3,852,655	$1,068,675	$899,787
2009	5,000	$750,000	$2,033,980	$2,783,980	$3,192,925	$750,000	$3,942,925	$1,158,945	$2,058,732
2010	7,500	$1,125,000	$2,033,980	$3,158,980	$4,924,791	$1,125,000	$6,049,791	$2,890,811	$4,949,543
2011	7,500	$1,125,000	$2,033,980	$3,158,980	$5,060,195	$1,125,000	$6,185,195	$3,026,215	$7,975,758
2012	7,500	$1,125,000	$2,033,980	$3,158,980	$5,195,599	$1,125,000	$6,320,599	$3,161,619	$11,137,377
2013	7,500	$1,125,000	$2,033,980	$3,158,980	$5,331,004	$1,125,000	$6,456,004	$3,297,024	$14,434,401
2014	7,500	$1,125,000	$2,033,980	$3,158,980	$5,466,408	$1,125,000	$6,591,408	$3,432,428	$17,866,829
2015	7,500	$1,125,000	$2,033,980	$3,158,980	$5,601,812	$1,125,000	$6,726,812	$3,567,832	$21,434,661
2016	7,500	$1,125,000	$2,033,980	$3,158,980	$5,737,216	$1,125,000	$6,862,216	$3,703,236	$25,137,897
2017	7,500	$1,125,000	$2,033,980	$3,158,980	$5,872,620	$1,125,000	$6,997,620	$3,838,640	$28,976,538
2018	7,500	$1,125,000	$2,033,980	$3,158,980	$6,008,025	$1,125,000	$7,133,025	$3,974,045	$32,950,582
2019	7,500	$1,125,000	$2,033,980	$3,158,980	$6,143,429	$1,125,000	$7,268,429	$4,109,449	$37,060,031
2020	7,500	$1,125,000	$2,033,980	$3,158,980	$6,278,833	$1,125,000	$7,403,833	$4,244,853	$41,304,884
2021	7,500	$1,125,000	$0	$1,125,000	$6,414,237	$1,125,000	$7,539,237	$6,414,237	$47,719,121
Totals:	125,000	$18,750,000	$40,679,600	$59,429,600	$88,398,721	$18,750,000	$107,148,721	$47,719,121	$47,719,121

[1] Assumed market demand

[2] Debt service assumes $26 Million revenue bond and 25 percent USBR construction funds (Title XVI).

[3] R/W rates 25 percent below tiered potable rates.

[4] Assumes $150/AF Regional Agency Rebate

CONTINUATION OF TABLE 4-2
Medium Sized Project Reccycled Water Assumptions
Federal Grant Funds Combined With Long Term Debt

	FY-2000	FY-2001	FY-2002	FY-2003	FY-2004	FY-2005	FY-2006	FY-2007	FY-2008	FY-2009	FY-2010
Cost/Sales Price of Water ($/af)											
Potable Water											
1st Block	123	130	136	144	151	158	165	172	179	186	193
2nd Block	661	684	707	731	756	782	805	829	853	877	901
3rd Block	737	762	788	815	842	871	896	923	950	977	1003
Recycled Water											
1st Block	111	117	122	130	136	142	148	155	161	167	174
2nd Block	595	616	636	658	680	704	724	746	768	789	811
3rd Block	663	686	709	734	758	784	807	831	855	879	903
MWD LRP Rebate	150	150	150	150	150	150	150	150	150	150	150
Power	30	30	30	30	30	30	30	30	30	30	30
Sales Volume (afy)											
Volume (afy)	0	1,000	2,000	3,000	4,000	5,000	5,000	5,000	5,000	5,000	7,500
1st Block	0	300	600	900	1,200	1,500	1,500	1,500	1,500	1,500	2,250
2nd Block	0	300	600	900	1,200	1,500	1,500	1,500	1,500	1,500	2,250
3rd Block	0	400	800	1,200	1,600	2,000	2,000	2,000	2,000	2,000	3,000
Water Revenues ($)											
Recycled Water	$0	$494,100	$1,022,580	$1,588,950	$2,192,040	$2,836,800	$2,922,116	$3,012,386	$3,102,655	$3,192,925	$4,924,791
MWD LRP Rebate	$0	$150,000	$300,000	$450,000	$600,000	$750,000	$750,000	$750,000	$750,000	$750,000	$1,125,000

	FY-2011	FY-2012	FY-2013	FY-2014	FY-2015	FY-2016	FY-2017	FY-2018	FY-2019	FY-2020	FY-2021
Cost/Sales Price of Water ($/af)											
Potable Water											
1st Block	200	207	214	221	228	235	242	249	256	263	270
2nd Block	925	950	974	998	1022	1046	1070	1094	1119	1143	1167
3rd Block	1030	1057	1084	1110	1137	1164	1191	1217	1244	1271	1298
Recycled Water											
1st Block	180	186	193	199	205	212	218	224	231	237	243
2nd Block	833	855	876	898	920	941	963	985	1007	1028	1050
3rd Block	927	951	975	999	1023	1048	1072	1096	1120	1144	1168
MWD LRP Rebate	150	150	150	150	150	150	150	150	150	150	150
Power	30	30	30	30	30	30	30	30	30	30	30
Sales Volume (afy)											
Volume (afy)	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500
1st Block	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250
2nd Block	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250
3rd Block	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Water Revenues ($)											
Recycled Water	$5,060,195	$5,195,599	$5,331,004	$5,466,408	$5,601,812	$5,737,216	$5,872,620	$6,008,025	$6,143,429	$6,278,833	$6,414,237
MWD LRP Rebate	$1,125,000	$1,125,000	$1,125,000	$1,125,000	$1,125,000	$1,125,000	$1,125,000	$1,125,000	$1,125,000	$1,125,000	$1,125,000

Findings

1) Net Revenues to the medium-sized project increase with the conversion to recycled water. This is because the majority of the irrigation use is in the upper third tier of the rate structure.
2) The utility experiences a greater positive cash flow sooner with the recycled water project.
3) All customers will save the reduction in imported water purchase costs (purchased water adjustment charge). Conversion to recycled water avoids future rate increases resulting from increased imported water purchase.

Table 4-2 provides an example of a financial cash flow analysis for the medium sized recycling project (5,000 AF/Y). Service to users with varying recycled water demands were identified over a more widespread area. This requires the construction of more than one backbone pipeline with the addition of several lateral connections. This project is assumed to be debt financed at market interest rates over a 30 year period and Title XVI water recycling grants funding (25 percent of construction cost.

The regional agency rebate in this example was assumed to be $150/AF. Additional financial scenarios could be developed using other rate and capital funding options. For example, the recycled water rate discount of 20 percent may need to be significantly higher to encourage existing customers to retrofit their existing on-site plumbing to use recycled water. In the Section on "Customer Acceptance (4.5.1)," the data on recycled rates show they have been discounted as low as 48 percent (City of Long Beach).

Comparing Financing Alternatives

Alternative debt service and funding options should be compared and used in the analyses with Federal Grants Funds, SWRCB low interest loans, and other rate and debt financing options to optimize the cash flow of the project. Multiple analyses are generally required to compare financing options and the associated cash flow impacts.

In Section 2, it was discussed that others beyond the retail producer/purveyor experienced benefits from recycling projects. In recognition of those benefits, funding participation from other sources is available to the producer/purveyor of recycled water. This payment for benefits received takes the form of low interest loans and grants for design and construction. In some areas of California, financial operating incentives are available to qualified projects to defray costs (MWD, SCVWD, and SDCWA). These programs are provided by regional suppliers who experience reliability benefits from a local recycling project. When analyzing the financial feasibility of a project, access to these programs should be determined and the financial analysis should be done with and without these sources.

4.1 CAPITAL FUNDING SOURCES

Recycled projects generally require significant capital expenditures. Amortizing the capital costs of a project or a portion of it is critical to the financial feasibility of the project. Typical debt financing options are described below:

- **Municipal Tax-Exempt Bonds** – Allow the total capital construction activities for the recycling project to be financed from the sale of long-term (20 – 30 years) revenue bonds or from certificates of participation.
- **Federal Grants (USBR Title XVI program)** – Provide up to 25 percent of the construction costs for qualifying projects ($20 million limit).
- **State of California low interest loans or grant funds** per SWRCB water recycling funding guidelines and Proposition 204.

Public agencies can also obtain funds from private sources, such as:

- **Capital Contribution** – some districts have entered into special agreements with developers or industrial users, requiring the contribution of either assets (e.g., pipelines) or money to offset the costs of a particular project connection fees.

4.1.1 Municipal Tax-Exempt Bonds

A major source of capital financing for a municipality is to assume debt, that is, to borrow money by selling tax-exempt bonds. Depending upon the enabling legislation, voter approval may or may not be required. Among the types of bonds commonly used for financing public works projects are:

- **General Obligation Bonds** – Repaid through collected general property taxes or service charge revenues; generally requires a referendum vote.
- **Special Assessment Bonds** – Repaid from the receipts of special benefit assessments to properties (and in most cases, backed by property liens if not paid by property owners).
- **Revenue Bonds** – Repaid through user fees and service charges derived from operating reuse facilities (useful in regional or sub-regional projects because revenues can be collected from outside the geographical limits of the borrower).
- **Certificates of Participation** – generally the same as revenue bonds.
- **Short-Term Notes** – Usually paid through general obligation or revenue bonds (tax exempt commercial paper and revenue anticipation notes).

A municipal finance director and/or bond advisor can describe the requirements to justify the technical and economic feasibility of the reuse project. The municipality must substantiate projections of the required capital outlay, the anticipated operation, maintenance and replacement (OM&R) costs, the cash flow from revenue-generating activities (i.e., the user charge system, etc.) and the extent to which anticipated capital amortization and operations, maintenance, and replacement costs are covered by potential revenues.

4.1.2 State of California Financial Assistance

The State Water Resources Control Board (SWRCB) has three programs to provide financial assistance to local agencies for water recycling projects. Grant funding is limited to feasibility planning studies under the Water Recycling Facilities Planning Grant Program (FPGP). However, low interest loans are also available for planning under the State Revolving Fund (SRF). Low interest loans are more commonly utilized to fund the design and construction of water recycling projects under the Water Recycling Loan Program (WRLP) or SRF.

DWR also has low interest loans that could be utilized by a project sponsor to finance a portion of the capital costs. The water conservation and groundwater program is just one example.

A summary of Proposition 204, funding for SWRCB, and DWR programs are presented in Table 4-3 and is followed by a description of each program. The application processes for the SWRCB and DWR funding programs are illustrated in Figures 4-1 and 4-2, respectively.

TABLE 4-3
PROPOSITION 204 FUNDING SUMMARY

Program	Amount	Responsible Agency
Delta Improvements		
Central Valley Project Improvement Program	93m	Controller
Bay-Delta Agreement Program	60m	Resource Agency
Delta Levee Rehabilitation Program	25m	DWR
South Delta Barriers Program	10m	DWR
Delta Recreation Program	2m	Dept. of Parks & Recreation
CALFED Bay-Delta Programs	3m	DWR
Subtotal	**$193m**	
Clean Water and Water Recycling		
Clean Water Loans and Grants		
Clean Water Loans	80m	SWRCB
Small Community Grants	30m	SWRCB
Water Recycling	60m	SWRCB
Drainage Management	30m	SWRCB
Delta Tributary Water Shed Program	15m	SWRCB
Seawater Intrusion Control	10m	SWRCB
Lake Tahoe Water Quality	10m	California Tahoe Conservancy
Subtotal	**$235m**	
Water Supply Reliability		
Feasibility Projects	10m	DWR
Water Conservation/Groundwater Recharge	30m	DWR
Local Projects	25m	DWR
Sacramento Valley Water Management and Habitat Protection Measures	25m	DWR
River Parkway Program	27m	Legislative Approval/Appropriation
Subtotal	**$117m**	
CALFED Bay-Delta Ecosystem Restoration Program	$390m	Resource Agency
Flood Control Subventions	$60m	DWR
TOTAL	**$995m**	

STATE WATER RESOURCES CONTROL BOARD
State Revolving Fund
Maximum $20 Million

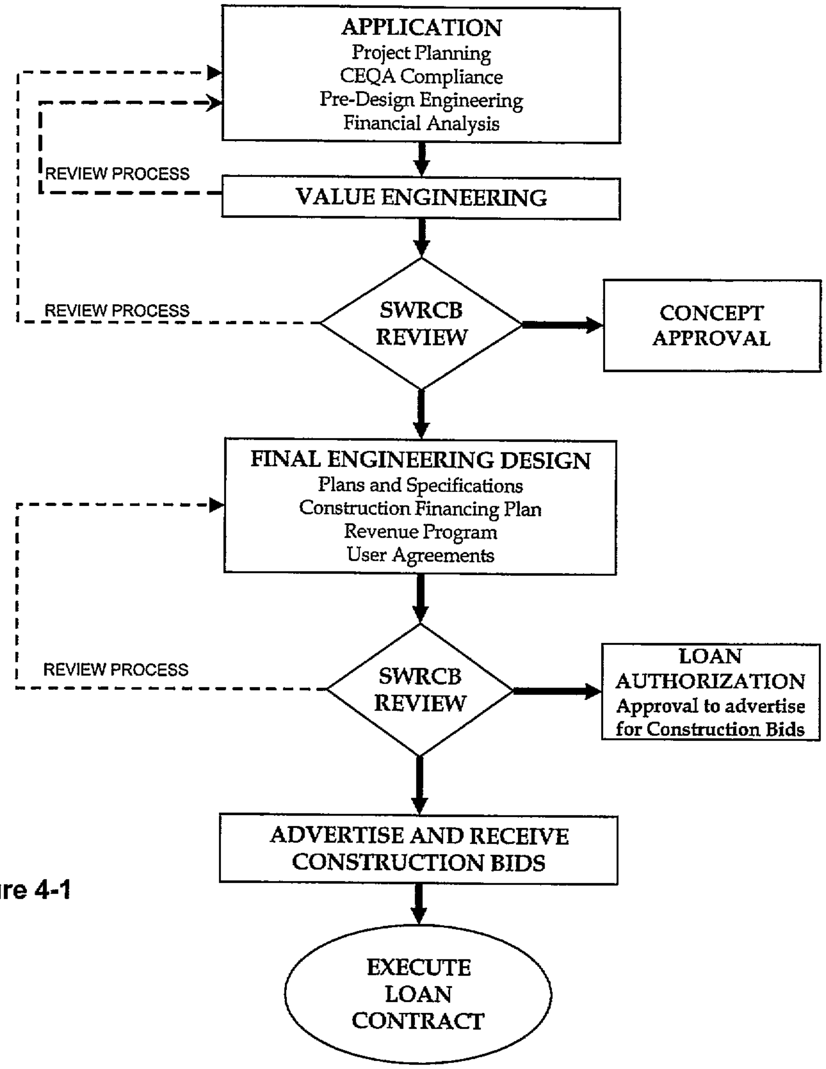

Figure 4-1

DEPARTMENT OF WATER RESOURCES
Water Conservation Bond Law of 1988
Maximum $5 Million Loan

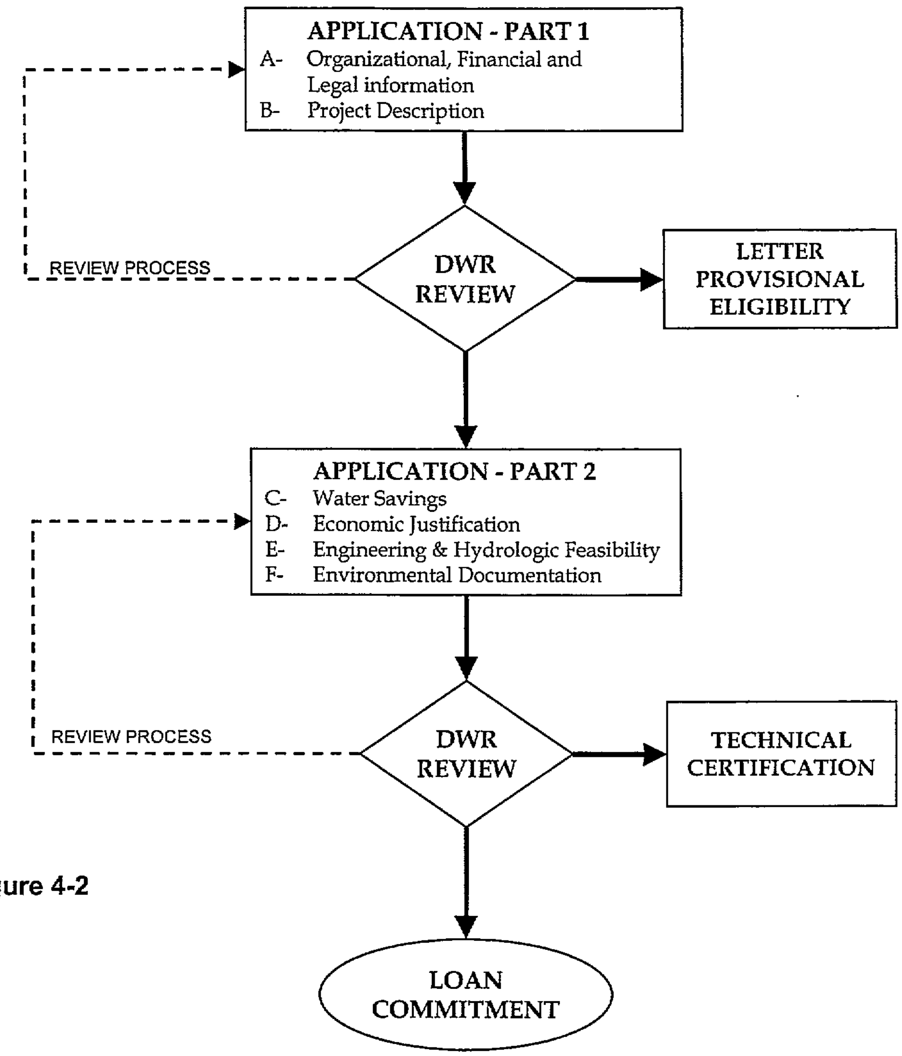

Figure 4-2

CLEAN WATER AND WATER RECYCLING PROGRAM

The Clean Water and Water Recycling Program of Proposition 204 is allocated a total of $235 million for implementation of the following articles:

- ***Clean Water Loans and Grants ($110 million)*** -- The funds allocated to this article are appropriated to the State Water Resources Control Board (SWRCB) as follows:
  - $80 million to the State Revolving Fund Loan Subaccount to provide loans pursuant to the Clean Water Act, to aid in the construction or implementation of eligible projects, or for investigations (contracted or otherwise) necessary or desired by the SWRCB to carry out this plan, including the preparation of comprehensive statewide or regional studies on collection, treatment, and disposal of waste under a comprehensive cooperative plan. The loans are for 20 years at half the State of California general obligation bonds interest rate at time of issuance (about 3 to 3.5 percent)
  - $30 million to the Small Communities Grant Subaccount for grants by the SWRCB to small communities for construction of eligible treatment works. The total amount of a grant made to any single project may not exceed $3.5 million.

Eligible projects refer to projects which are a) necessary to prevent water pollution or to reclaim water, b) eligible for funds from the State Revolving Fund Loan Account or federal assistance, c) certified by the SWRCB as entitled to priority over other eligible projects, and d) comply with applicable water quality standards policies and plans.

- ***Water Recycling ($60 million)*** -- On-going SWRCB loans and grants program to public agencies for design and construction of recycling project and for construction, operation and maintenance of eligible recycling projects. The funds allocated to this article are appropriated to the SWRCB for the following purposes:
  - Loans to public agencies to construct, operate, and maintain eligible recycling projects.
  - Loans to aid in the design and construction of eligible recycling projects.
  - Grants to public agencies for facility planning studies for water reclamation projects. The amounts of these grants are not to exceed $75,000 per study.
  - To undertake, by contract or otherwise, plans, surveys, research, development, and studies necessary or desirable by the SWRCB to carry out the purposes of this article. The SWRCB may also undertake, by contract or otherwise, the preparation of comprehensive statewide or area wide studies and reports on water recycling and the collection, treatment, disposal, and distribution of wastewater under a comprehensive cooperative plan. The total costs of such studies together with cost incurred with the administration of this article are not to exceed $1.8 million.

The term "eligible recycling projects" refers to water reclamation projects which meet applicable reclamation criteria and water reclamation requirements and that comply with applicable water quality standards, policies, and plans.

The SWRCB staff contact is Lynn Johnson (916/227-4580). Note SWRCB low interest loans (about 3 to 3.5 percent) have been very bureaucratic and require substantial effort to secure approval.

➢ ***Water Conservation*** and ***Groundwater Recharge ($30 million)*** -- On-going DWR loans to local public agencies for land acquisition and construction of water conservation programs. Maximum loan amount of $5 million. DWR loans under this program can be utilized for land acquisition and construction. The funds allocated to this article are appropriate to the DWR for the following two activities:

- $25 million for loans to local agencies to aid in the acquisition and construction of voluntary, cost-effective capital outlay water conservation programs and groundwater recharge facilities.

  "Capital outlay water conservation programs" are those feasible capital outlay measures which improve the efficiency of water use. No project shall receive more than $5 million in loan proceeds from the DWR. Programs/projects to improve the efficiency of water use include:

  a) lining or piping of ditches, or canals,
  b) improvements to water distribution system controls to conserve water which has already been captured,
  c) tailwater pumpback recovery systems,
  d) major improvements to distribution system to reduce leakage,
  e) capital changes in on-farm irrigation system which improve irrigation efficiency such as sprinkler or subsurface drip,
  f) capital outlay features of urban water conservation programs identified in the "Memorandum of Understanding Regarding Urban Water Conservation in California," and
  g) conveyance facilities in a county of the third class (less than a population of 250,000), including appurtenances, necessary to implement a long-term conservation program to transfer conserved water from areas not directly receiving water from the bay-delta to those areas that receive water from the Bay-Delta and whose demands on the Bay-Delta would be reduced as a result of the transfer.

"Groundwater recharge facilities" are lands and facilities for artificial groundwater recharge through methods which include, but are not limited to, percolation using basins, pits, ditches and furrows, modified stream bed, flooding, well injection, and in-lieu recharge. "Groundwater recharge facilities" also means capital outlay expenditures to expand, renovate, or restructure land and facilities already in use for the purpose of groundwater recharge and to acquire additional land for retention and detention basins.

- $5 million for a grant to a local agency for the development of supplemental water sources, distribution systems, and recharge facilities in a watershed that is in a state of overdraft and whose ability to locally finance the facilities has been adversely affected by the Base Closure and Realignment Act of 1990 (This was written in for Mojave Water Agency related to George AFB). DWR staff contact is Dan Ortis (916/327-1657).

➢ ***Feasibility Projects ($10 million)*** -- DWR administers this new program. The funds allocated to this article are appropriated to the DWR for feasibility and environmental investigations for any of the following projects:

- Off-stream storage upstream of the Delta that will provide storage and flood control benefits in an environmentally sensitive and cost-effective manner.
- Regional water recycling that may include partnerships or other cooperative efforts undertaken by water agencies, wastewater discharges, or other public agencies to collect and reuse treated municipal wastewater for agricultural, industrial, turf irrigation or environmental purposes.
- Water transfer facilities in a county of the third class that would increase the capacity for delivering Colorado River Water for use in the southern California coastal plain and reduce the demands on the bay-delta.
- Desalination.

It appears that DWR has allocated $4 million for the Sites off-stream Reservoir in the Sacramento Valley and potentially some funds for San Diego County Water Authority for its proposed emergency storage project. DWR staff contact: Bill Bennett (916/529-7342) Redding Office.

➢ ***Seawater Intrusion Control ($10 million)*** -- The funds allocated to this article are appropriated to the SWRCB for loans to local agencies to carry out eligible seawater intrusion control projects. Eligible seawater intrusion control projects are those threatened by seawater intrusion in an area where restrictions on groundwater pumping, a physical solution, or both, are necessary to prevent the destruction of groundwater quality.

4.1.3 Bureau of Reclamation Title XVI Water Recycling Program

In October 1992, Congress approved passage of the landmark Miller/Bradley water bill (Public Law 102-575). Title XVI of P.L. 102-575 provided the authority for the USBR to participate up to 25 percent of the construction costs of four water recycling programs in California:

- Los Angeles Area Water Reclamation and Reuse Project (including WBMWD)
- San Diego Area Reuse Program
- San Jose Area Reuse Program
- San Gabriel Basin Reuse Program Demonstration Project

In addition, two comprehensive regional reuse studies were also authorized: Southern California (Imperial, Los Angeles, San Bernardino, Riverside, San Diego, and Ventura counties – six year study); and San

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Francisco Bay area 4-year study. Both studies provide for a 50/50 federal cost-sharing arrangement.

The enactment of the Reclamation Recycling and Water Conservation Act of 1996, which amended Title XVI of P.L. 102-575, authorized another 16 recycling projects and two desalination projects (see Table 4-4). The key provisions of the 1996 law are:

- Maintain a maximum Federal contribution of 25 percent of the total construction cost (O&M expenditures are not eligible):
- Establish a $20 million cap for federal cost-sharing contributions to each project; and
- Require completion of an appraisal investigation and a feasibility study prior to federal grant appropriations.

TABLE 4-4
ADDITIONAL AUTHORITY FOR WATER RECLAMATION AND REUSE

President Clinton signed into law the Reclamation Recycling and Water Conservation Act of 1996 on October 9, 1996. Public Law 104-266 authorizes the Bureau of Reclamation to participate in the design, planning, and construction of 16 new water reclamation and reuse projects. The 16 projects are listed below:

California

- North San Diego County Area Water Recycling Project
- Calleguas Municipal Water Recycling Project
- Wastonville Area Water Recycling Project
- City of Pasadena
- Phase 1 of the Orange County Regional Water Reclamation Project
- Hi-Desert Water District in Yucca Valley
- Mission Basin brackish Groundwater Desalting Demonstration Project
- Treatment of Effluent from the Sanitation Districts of Los Angeles County through the City of Long Beach
- San Joaquin Area Water Recycling and Reuse Project

Utah

- Central Valley Water Recycling Project
- St. George Area Water Recycling Project
- Tooele Wastewater Treatment and Reuse Project
- City of West Jordan Water Reuse Project

Nevada

- Southern Nevada Water Recycling Project

New Mexico

- Albuquerque Metropolitan Area Water Reclamation and Reuse Study

Texas

- El Paso Water Reclamation and Reuse Project

The application process for Title XVI grants is illustrated in Figure 4-3.

US BUREAU OF RECLAMATION
Title XVI Water Recycling Grants
P.L. 102-575

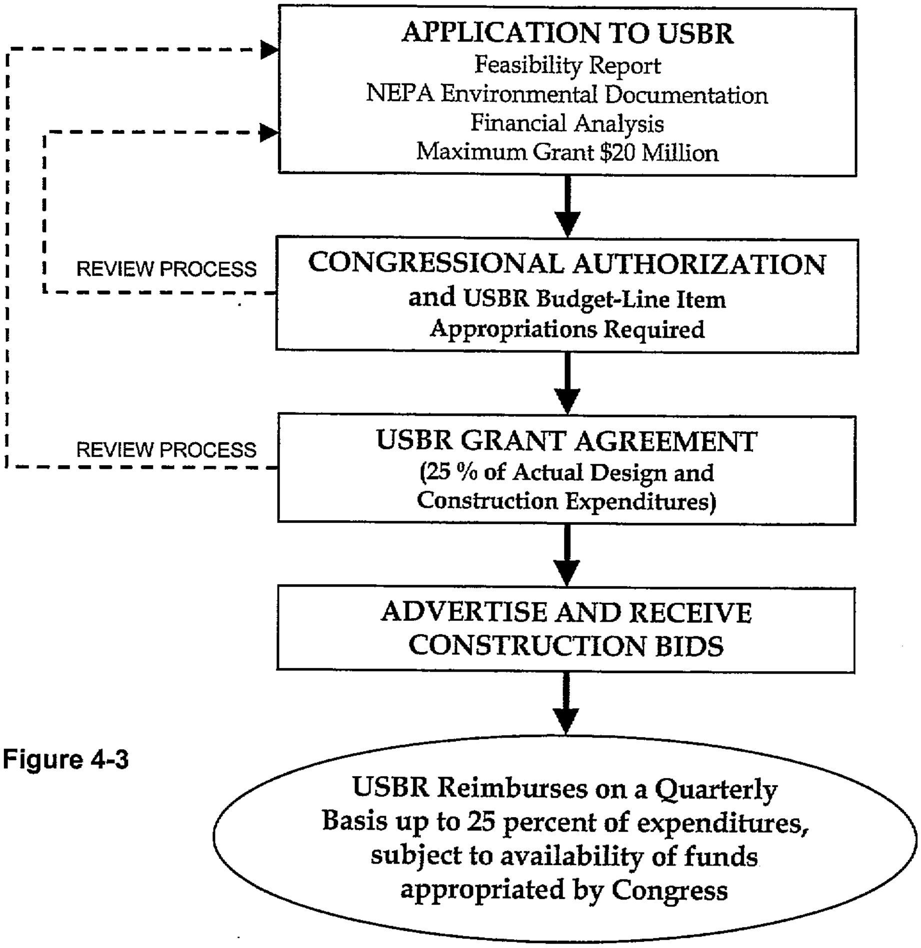

Figure 4-3

Public Law 104-266 Amended Title XVI (Reclamation, Recycling, and Water Conservation Act of 1996) Signed into Law by President Clinton on October 9, 1996.

4.1.4 Other Potential Federal Funding

In addition to the USBR Title XVI Water Recycling Program mentioned above, detailed below are additional potential federal funding sources for water recycling projects.

- **Army Corps** – In 1992, Congress passed the Water Resources Development Act, authorizing new water projects for the US. Army Corps of Engineers, including water recycling projects.
- **EPA** - The language of the Clean Water Act of 1977, and its subsequent amendments, supports water reuse projects through the following provisions:
  - Section 201 of PL 92-500 was amended to ensure that municipalities are eligible for "201" funding only if they have "fully studied and evaluated" techniques for "reclaiming and reuse of water."
  - Section 214 was added, which stipulates that the EPA administrator "shall develop and operate a continuing program of public information and education on recycling and reuse of wastewater
  - Section 313, which describes pollution control activities at federal facilities, was amended to ensure that WWTFs will utilize "recycle and reuse techniques: if estimated life-cycle costs for such techniques are within 15 percent of the most cost-effective alternative."
- **Farmers Home Administration (FmHA) of the U.S. Department of Agriculture (USDA),** - Under the FmHA programs, grants and loans are available to public agencies and non-profit corporations, which serve areas with populations under 10,000. The amount of the grant or loan is restricted by that amount necessary to lower the user costs to a reasonable rate, based on the median family income of the community. In addition, the sum of the FmHA grant and other state and federal grants cannot exceed 50 percent of the project costs. Thus, projects funded by Clean Water loans will not be eligible under FmHA program.
- **The U.S. Small Business Administration (SBA),** - provides low interest loans to small businesses for wastewater control equipment required by regulatory agencies. The funds can be used for pretreatment of industrial waste to reduce toxic and saline constituents in reclaimed water. For a project to be eligible for a loan from the SBA, the EPA must be able to certify that the project is required to comply with either federal or state water pollution control requirements and that other funds are not available.

4.2 WATER AND WASTEWATER REVENUES THAT MAY BE UTILIZED TO FINANCE A WATER RECYCLING PROJECT

While the preceding funding alternatives describe the means of generating construction capital, there is also a need to provide revenues for OM&R costs as well as to repay funds borrowed. In most cases, a combination of several funding sources will be used to cover capital and OM&R costs. Examples of various utility generated funding sources are listed below.

- Recycled customer user charges
- Operating budget and cash reserves of the utility to offset recycled water sales revenue shortfalls
- Local property taxes
- Potable water and wastewater rates and charges
- Special assessments or special community service tax districts
- Water standby charges on a per-parcel basis
- Developer connection fees
- Recycled Water Meter Maintenance Charges (or other fixed monthly service charges)

The estimation of the operating cost of a reclaimed water distribution system involves determination of those components of treatment, distribution, and that are directly attributable to the reclaimed water system. Direct operation costs involve advanced treatment facilities, distribution, additional water quality monitoring, inspection and monitoring staff. The costs saved from effluent disposal may be considered as a credit. Indirect costs include a percentage of administration, management and overhead. Another cost is replacement reserve, i.e. the reserve fund to pay for system replacement in the future. In fiscal year 1986/87, the Irvine Ranch Water District calculated this cost at 1.5 percent of the original facility cost (Young *et al*, 1987). The study also found that the total cost of producing and distributing reclaimed water (including acquisition of additional source water) was $303/ac ft ($0.93/1,000 gal). The cost of potable water distribution was $449/ac ft ($1.38/1,000 gal). The savings of $146/ac ft ($0.45/1,000 gal) over the life cycle of the project was considered nearly enough to pay the debt service on the capital cost of the dual distribution system (Young *et al.*, 1987).

4.2.1 Operating Budget and Cash Reserves

Activities associated with the planning and possibly preliminary design of reuse facilities could be funded out of an existing wastewater utility or department operating budget. In some instances, a water supply agency seeking to expand its water resources would find it appropriate to apply a portion of its operating funds in a similar way. In addition, available cash balances in certain reserve accounts may be utilized.

It may be appropriate, for example, to utilize funds from the operating budget for planning activities or business costs associated with assessing the reuse opportunity. Furthermore, if cash reserves are accruing for unspecified future capital projects, those funds could be used or a portion of the operating revenues can be set aside in a cash reserve for future needs. The obvious advantage of using this alternative source of funding is that the board or governing body of the water supply or wastewater treatment department or utility can act on its own initiative to allocate the necessary resources.

These sources are especially practical when relatively limited expenditures are anticipated to implement or initiate the reuse program, or when the reuse project will provide a general benefit to the entire community (as represented by the present customers of the utility). In addition, utilizing such resources is practical when the reclaimed water will be distributed at little or no cost to the users, and therefore will generate no future stream of revenues to repay the cost of the project. While it is ideal to fully recover all direct costs of each utility service from customers, it may not be practical during early phases of a reuse system implementation.

4.2.2 Local Property Taxes

If the resources available in the operating budget or the cash reserves are not sufficient to cover the necessary system OM&R activities and capital financing debt, then another source of funds to consider is revenue generated by increasing existing levies or charges. If some utility costs are currently funded with property taxes, levies could be increased and the new revenues designated for expenses associated with the reuse project. Similarly, the user charge currently paid for water and sewer services could be increased. As with the use of the operating budget or cash reserves, the use of property taxes or user charges may be desirable if the expenditures for the project are not anticipated to be sizable or if a general benefit accrues to the entire community. As a result of Proposition 218, voter approval of new property taxes or water standby charges would be required.

4.2.3 Water and Wastewater Rates

Water and wastewater rates are key revenue for most utilities. Revenue obtained from "user fees" fairly recovers costs from customer classes in accordance with class usage and demand patterns. Water rates today are generally tiered increasing block rates. Wastewater rates are commonly based upon metered water sales (factored for indoor consumption only) or are monthly flat fees based upon type of land use (e.g., single family residential, apartments, commercial).

Rate design and ratemaking are complex issues that tend to be controversial and require extensive public input. Developing recycled water rates needs to be coordinated with the water and wastewater rate structure to ensure that the customer has the proper economic incentive to use recycled water.

4.2.4 Special Assessments or Special Tax Districts

When a recycling program is designed to be a self-supporting enterprise, independent of both the existing water and wastewater utility systems, it may be appropriate to develop a special tax or assessment district to recover capital costs directly from the benefited properties. The advantage of this cost recovery mechanism is that it can be tailored to collect the costs appropriate to the benefits received. An example of an area using special assessments to fund dual water piping for fire protection and irrigation water is the City of Cape Coral, Florida, with an approximate cost of $1,600 per single family residence with financing over 8 years at 8 percent annual interest.

Special assessments may be based on lot front footage, lot square footage, or estimated gallon use relative to specific customer types. This revenue alternative is especially relevant if the existing debt for water and wastewater precludes the ability to support a reuse program, or if the area to be served is an independent service area with no jurisdictional control over the water or wastewater systems. Again, as a result of Proposition 218, voter approval by the landowners within the special assessment district would be required.

4.2.5 Water Standby Charges

Water districts may levy a water standby charge for each parcel within its service area for providing water available to the property. Water standby charges can be used for capital debt service, operating costs, and other purposes.

4.2.6 Developer Connection Fees

Develop connection fees or impact fees are a means of collecting the costs of constructing an element of infrastructure, such as water, wastewater, or reuse facilities, from those new customers benefiting from the service. Connection fees may be used to generate construction capital or to repay borrowed funds. Frequently, these fees are used to generate an equitable basis for cost recovery between customers connecting to the system in the early years of a program and those connecting in the later years. The carrying costs (interest and expense) are generally not fully recovered through the connection fee, although annual increases above a base cost do provide equity between groups connecting in the early years and those in later years.

Connection fees for water reuse systems are implemented at the discretion of the governing body. However, the requirement that a connection fee be paid upon application for service prior to construction can provide a strong indication of public willingness to participate in the reuse program. Incentive programs can be implemented in conjunction with connection fees by waiving the fee for those users that make an early commitment to connect to the reclaimed water system (e.g., within the first 90 days after construction completion) and by collecting the fee from later connections.

4.2.7 Meter Maintenance Charges

It is common for retail water utilities (and some wholesale water utilities) to charge a monthly fee for the maintenance and administration costs of providing water service to a customer, regardless of the amount of water consumed. For example, if a homeowner were to go on vacation for a month and hypothetically used zero water, the utility still has the expense of reading the meter, providing maintenance of the utility plant, and general administrative expenses of ensuring the utility is properly managed. Likewise a monthly meter charge for recycled water could be imposed, whether or not the customer purchases recycled water.

4.2.8 Recycled Water User Charges

How should the price to the recycled water customers be set? Generally, it will be related to the customer's current price for the potable water it will replace. A discount below the price of potable water is often an essential incentive to enlist the willing participation of potential customers in the program.

If the potential revenues from the sale of the water at a discounted price are too low to cover the OM&R and bond amortization costs of the project, other methods must be found to increase the revenue. For a water supply agency, the decision to implement a water recycling project should be made for sound policy and financial reasons – usually, because there is no other available, reliable and economic source of water to meet future needs. Therefore, the net cost of providing the supply of recycled water should be treated like the agency would treat any new water supply costs (i.e., the cost would be distributed uniformly over all potable and recycled water users in the water rates for the utility).

If the sales of reclaimed water exceed the unit cost of providing and delivering it, the agency is in a position to accumulate funds to meet future water needs or to lower the costs of potable water to customers.

If marketing considerations require it, there can also be justification for having further discounts for large users because the unit cost of delivering the recycled water to them is less than for small users.

4.3 DUAL PURPOSE AGENCIES

4.3.1 Allocating Costs Between Water Supply and Wastewater Disposal

Agencies which serve both wastewater and water supply functions for their service area have the opportunity to apportion costs or fees among potable water users, recycled water users and discharges to the wastewater collection system. One method of apportioning such costs takes into consideration the quantity and quality of the water, the reserve capacity that must be maintained, the use of any joint facilities, the means of conveyance, and the direct costs associated with each group.

A proportional allocation of costs can be reflected in the following equations (where $=costs):

Total $ wastewater service =	$ wastewater treatment to permitted disposal standards +
	$ effluent disposal +
	$ transmission +
	$ collection.

Total $ potable water service =	$ water treatment +
	$ water supply +
	$ transmission +
	$ distribution.

Total $ reclaimed water service =	[$ reclaimed water treatment -
	$ treatment to meet permitted disposal standards]+
	$ additional treatment +
	$ additional distribution

The above equations illustrate an example of distributing the full costs of each service to the allocated system and users. The first equation distributes only the cost of treating wastewater to currently required disposal standards, with any additional costs for higher levels of treatment, such as filtration, coagulation, or disinfection, appropriated to the cost of reclaimed water service. In the event that the cost of wastewater treatment is lowered by the reuse alternative because current effluent disposal standards are more stringent than those required for the reuse system, the credit accrues to the total cost of reclaimed water service. This could occur, for example, if treatment for nutrient removal had been required for a surface water discharge but would not be necessary for agricultural reuse.

For water reuse systems, the proportionate share basis of allocation may be most appropriate. The allocation should not be especially difficult, because the facilities required to support the reuse system should be readily identifiable. A rule of thumb might be to allocate the costs of all treatment required for compliance with NPDES permits; to wastewater charges and all additional costs, the costs of reclamation and conveyance of reclaimed water, would be allocated to the water reuse user charge, as long as it is less than the cost of potable water.

General administrative costs could also be allocated proportionately. All wastewater administration would be charged to the sewer use charge, and all additional administration to the water reuse user charge. In some cases, a reduced level of wastewater treatment will be required as a result of water reuse. The effect may be to lower the wastewater user charge. In this case, depending on local circumstances, the savings could be allocated to either or both the wastewater discharged and the reclaimed water user. It is ultimately a local decision on how costs are allocated.

4.3.2 Differential Pricing for User

With more than one reclaimed water user on the system, different qualities of reclaimed water may have to be produced. If so, the user charge becomes somewhat more complicated to calculate, but it is really no different than calculating the charges for treating different qualities of wastewater for discharge. If, for example, reclaimed water is distributed for two different irrigation needs, one requiring higher quality water than the other, the user fee calculation can be based on the cost of treatment to reach the quality required.

4.4 PHASING AND PARTICIPATION INCENTIVES

The financing program can be structured to construct the water reuse facilities in phases, with a percentage of financial commitment required prior to implementation of a phase. This commitment assures the municipal decision makers that the project is indeed desired and ensures the financial stability to begin implementation. Incentives can be used to promote early connections or participation, such as a reduction or waiver of the assessment or connection fee for those connections to the system within a set time frame (see Section 5).

4.5 OTHER ISSUES FOR ADOPTING WATER RATES AND PRICING POLICIES FOR RECYCLED WATER

4.5.1 Customer Acceptance

It is important, for a variety of reasons, that the customer of a public utility be willing to accept its pricing policy. Customer acceptance requires some understanding of the terms of the rate design as well as a belief in its overall adequacy, efficiency, and fairness. Customers are themselves water purveyors, and they are relatively sophisticated on the subjects of rate design and water management; thus, policies which strike a reasonable balance among competing objectives can be expected to win acceptance.

The water rates of a water district for wholesale service of recycled water should be less than the rate for a potable water supply to a retail purveyor. Retail rates for recycled water are often less than retail potable water rates so as to provide an economic incentive for users to connect to the recycled water system. For reference, Table 4-5 lists the 1993 recycled water rates of purveyors in the Central Basin area of Los Angeles County.

The timely establishment of recycled water rates by retailers is an important consideration in the pace at which users accomplish the necessary on-site retrofit work. To accomplish this, retailers must establish a tariff schedule for recycled water in advance of its availability, so that the user is certain of the ability to amortize retrofit costs with purchased water savings. An additional key issue in retail rates is the use of fixed monthly meter charges and the possibility that these charges may be a disincentive to customers to retrofit to recycled water.

TABLE 4-5
CBMWD SERVICE AREA
RETAIL POTABLE AND RECYCLED WATER RATES (1993)
($ PER ACRE-FOOT)

Retailer	Potable	Recycled	Percent Discount
Bellflower-Somerset	522.72	392.04	25
City of Cerritos	413.82	217.80	47
City of Downey	411.64	329.31	20
City of Lakewood	439.96	370.26	16
City of Long Beach	476.55	249.60	48
LADWP	496.58	397.27	20
Park Water Company	573.25	471.32	18
Peerless	546.68	470.45	14
City of Santa Fe Springs [1]	627.26	500.94	20
City of South Gate	644.69	579.35	10

1 Potable rate is a base commodity charge.

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4.5.2 Recycled Water Cost vs. Local Groundwater Cost

Recycled water rates may need to be cost effective when compared to local groundwater pumping costs. Costs to produce groundwater include energy and possibly a replenishment assessment. Substituting recycled water for groundwater will allow a retail agency to do one of two things: (1) purchase less imported water, or (2) lease groundwater rights to another agency (a positive revenue impact). Under scenario number 2, the net cost to the retail agency results in a recycled water rate which is less expensive than the cost of pumping groundwater.

Taking this analysis one step further demonstrates that recycled water to be even more cost effective than groundwater. For example, WBMWD in Los Angeles County is responsible for all capital, operation and maintenance, and replacement costs associated with the West Basin Water Recycling Project. Costs to the retail agency are only the purchase price of the recycled water and on-site retrofit costs, should they choose to provide that service to the end users. In contrast, the costs associated with producing groundwater include maintenance, well and pump replacement, and loss of water right lease revenue.

4.5.3 Recycled Water Rates Outside An Agency's Service Area

Sometimes a recycling project sponsor delivers recycled water to customers outside its service area through a retail purveyor. This is additional revenue which may make the project more financially feasible. However, there is the issue of what price to charge for customers outside the service area.

Pricing the recycled water higher for these areas ensures that only those areas which contribute to the standby charge revenue benefit from the internal fixed revenue of the district. Recycled water users outside the service area of the district ultimately would pay their full share of the costs.

4.5.4 On-Site Plumbing Retrofit Fund

Although the recycled water rates will be economical when compared to the cost of imported water or pumping groundwater, some users may not have the financial capability to pay for the on-site plumbing retrofit necessary to accept the recycled water. For example, a school district may not have any available capital funds to retrofit a school to convert the landscape irrigation system to recycled water and separate the rest of the plumbing for drinking water. A district or an agency could advance funds for these expenses, including any engineering work and County Health Inspections, and then be reimbursed through a flat monthly fee. The on-site facilities would be amortized over ten years at the prevailing borrowing rate (approximately 7 percent). This on-site facilities fee would be in addition to the recycled water rate.

The purpose of this on-site plumbing retrofit program is to ensure that a user can receive the benefit of the recycled water immediately and lower his cost of water service. The District and all of its users benefit by reducing the dependency on imported water and receive income for the recycled water sales. By having the on-site plumbing retrofit costs reimbursed with interest, no other user of District or resident is subsidizing the on-site facilities costs.

4.5.5 Lateral Pipeline Extension Policy

A "backbone" distribution system should be developed first for those most economical to serve. Therefore, not every potential user within the service area is targeted to receive recycled water in Phase I. At the request of a particular recycled water retailer or customer, the district can extend laterals to new users, if the costs for these extensions can be recovered within ten years (WBMWD/CBMWD policy). For example, a city may request the installation of 2,500 feet of pipeline to serve a city park with recycled water. The capital costs for this extension would be amortized over ten years at the district's borrowing rate (approximately 7 percent). If these costs could be recovered with recycled water sales to the city park, then the district will proceed with the extension. Alternatively, if the costs would not be recovered, the district could enter into a joint partnership with the city in which the city pays a portion of the costs. The purpose of this general policy is to maximize the use of recycled water to the extent it is cost effective and avoid financing high cost laterals that benefit only one community.

4.6 KEY REFERENCES

1) SWRCB - Water Funding Guidelines and Facilities Planning Grant Application, April 1997.

2) USBR Title XVI Draft Guidance Documents:
   - "Water Recycling, The Future is Here," December 1996.
   - "Preparing, Reviewing, and Processing Proposed Water Reclamation and Reuse Project Under Title XVI," Discussion Draft, May 1997.

3) West Basin Municipal Water District, "Recycled Water Ratesetting Policy," June 1993.

4) Central Basin Municipal Water District, "Recycled Water Ratesetting Policy," June 1993.

5) Metropolitan Water District of Southern California, "Request for Proposals, Local Resources Program, Recycled Water and Groundwater Recovery Projects," June 1998.

Section 5

ENHANCING THE FEASIBILITY OF WATER RECYCLING

The key to success for any water recycling project is ensuring that the customers receive a reliable water supply of acceptable quality, quantity, and pressure. The standards and guidelines for hooking up customers to recycled water are different from potable water service. This section discusses ways to enhance the feasibility of a water recycling project by encouraging public acceptance through the provision of excellent service and incentives, as well as meeting basic requirements.

5.1 HOW THE UTILITY CAN ENHANCE CUSTOMER SATISFACTION

One of the most important issues for the retail water purveyor is meeting the customers needs and making the transition to the recycling water system as trouble free as possible. The agency can take steps during the project planning to assist the customers to ensure for successful implementation of the project.

5.1.1 Make Plumbing Connections User Friendly for the Customer

The distinguishing features of either new or retrofitted onsite recycled water distribution systems are contained in the Guidelines for Distribution of Nonpotable Water prepared by the California-Nevada Section of the American Water Works Association (AWWA). The California Department of Health Services (DOHS) and the WateReuse Association have adopted the Guidelines for Distribution of Nonpotable Water. The revised version of the AWWA Retrofit Guidelines can now be purchased from the Cal/Nev Section of the AWWA (909/930-1200). The rules for prevention of cross connections are contained in Title 17 of the California Code of Regulations.

DOHS requires that "engineering reports" be prepared for each recycled water user to document and verify that the plumbing system for recycled water is separate from the potable system. To streamline the process of preparing individual engineering reports, many water and wastewater

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agencies prepare generic manuals that have been reviewed and approved by the DOHS and then file customer specific engineering reports. Typically, the water or wastewater agency does all the technical and administrative work related to cross-connection control to ensure that the engineering reports are approved by the DOHS in compliance with Title 17.

Among the principles included in the AWWA *Guidelines* are recommendations that potable and nonpotable piping and fittings be clearly distinguishable from each other. Reclaimed water piping is usually purple PVC, whereas potable piping may be galvanized iron, copper, or a differently colored PVC. In addition, all piping used for both potable or nonpotable water located in the same vicinity must be labeled with a tape attached to the pipe or by stenciling on the pipe. Triangular shaped valve covers are used on reclaimed water valves to distinguish them from the circular covers used for the potable water system. Reclaimed water meter boxes and valves and other exposed equipment are painted blue or purple to further preclude cross connections. Hose bibs are not allowed on reclaimed water systems. Quick coupling valves are operated by key using an Acme thread that is not allowed on the potable water system. The quick coupling valves are also different in color and material.

5.1.2 PUBLIC ACCEPTANCE AND INVOLVEMENT PROGRAMS

Purpose: Provide effective programs and plans to inform and build consensus among interested parties and the public.

A water recycling project needs broad public support and interagency cooperation to be successful. A public affairs program should be designed to target the multiple audiences that include:

- Public
- Media
- Community and business leaders (i.e., chambers of commerce, environmental interest groups, etc.)
- Customers (including their employees)
- Local government (i.e., cities, school districts, etc.)
- Regulatory agencies
- Local (retail) water and wastewater utilities

- Regional and state water agencies
- Elected officials (e.g., legislative and congressional members)
- Other key interested leaders.

Throughout the entire process of developing a water recycling project, (e.g., initial planning concept studies of full-scale operation), an intergovernmental and public affairs program needs to be actively maintained to ensure communication of the benefits of water recycling. Because issues and concerns can arise at unexpected times, it is wise to always have a positive message to ensure that misinformation and scare tactics do not overwhelm the agency. Elements often involved in an effective public affairs program are discussed below.

Generally, the purpose of the public involvement plan for a water recycling project is to provide project information and develop consensus on the implementation of the project. Typical public involvement activities are:

- Identify target audiences and interested parties;
- Inform interested individuals, groups, and the general public about the project;
- Determine appropriate public involvement opportunities to achieve agreement of proposed actions and policies;
- Establish effective media relations;
- Involve appropriate interested individuals and group representatives in identifying critical public issues; and
- Be responsive to public and agency input.

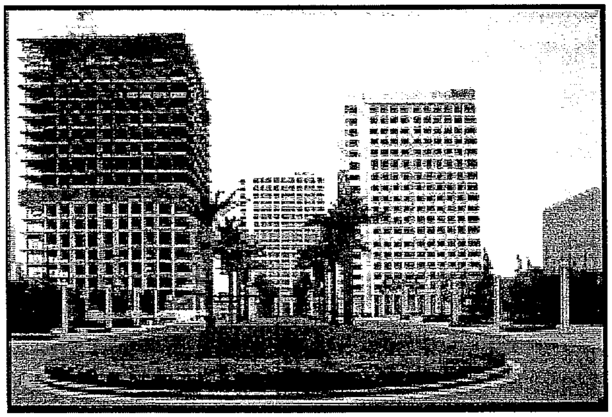
TABLE 5-1 A MENU OF PUBLIC OUTREACH ACTIVITIES
Citizens Committees Seek Community support and advocates for recycled water
Workshops Public meeting, forums, speakers bureau Technical advisory group Public hearings
Peer Review Expert network to assist on key water quality and other technical issues
Regular briefings of opinion leaders and elected officials
Newsletters
Videos/Cable TV community service
Fact Sheets/Brochures/Briefing Books
School Programs

In general, a public outreach program should be "customized" to the community. Obviously, the size and scale of the recycled water project and the population served dictates the level of activities. When initiating a public involvement program, some typical questions asked of potential stakeholder representatives from interested groups can include:

- Before you were contacted about the interview, did you know about the proposed program? If you did, how and from whom did you obtain the information?
- Having heard a brief description of the study and some of the major elements that will be included, are there any issues that have been missed or ignored?
- What major issues do you expect to arise as a result of this proposed project? In relation to California water quality and supplies?
- What two or three issues are of particular interest to your agency/organization/ constituency? Geographic area?
- Who else do you think needs to be involved or know about this project?
- When communicating about the proposed project, what do you think will be critical to the message?
- Are there particular communication techniques or methods that you have found effective? What meeting formats and locations do you prefer?
- At what level would you like to remain involved with the project?
- Are there any other comments or concerns that we have not yet addressed?

5.1.3 Capitalize on New Residential and Commercial Land Development Opportunities

Land use master planning gives a jurisdiction the ability to design a recycled water supply system that will be convenient to install once recycled water

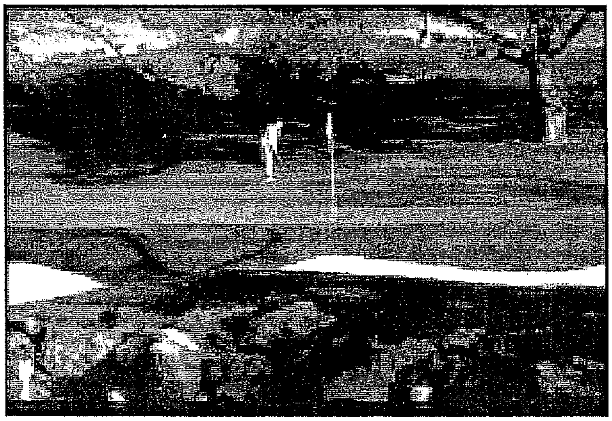


becomes available. For example, if a city or other public agency can anticipate that it will have a substantial wastewater supply available in future years, whether purchased from others or provided from future wastewater flows, the master plan can identify the largest potential customers and appropriate delivery routes. Ordinances can be adopted which require new developments to design dual water supply systems around public areas, homes, or in new commercial buildings. Landscaping along roads and medians can be designed so that there will be a minimum of connections required to substitute recycled water for the potable water. Stubouts and valves can be required which will allow the recycled water supply to be connected without shutting down the irrigation system. However, the key to successfully advanced planning is a commitment from the community to support use of the reclaimed water when it becomes available.

5.1.4 Consider Providing Financing for Customer Retrofits

In order to use recycled water, retrofitting the plumbing or distribution system is often required for users such as golf courses or manufacturing plants (see Cal/Nev Section AWWA *Retrofit Guidelines*). If the facility is old and recycling was not anticipated, the cost of replumbing may be greater than the value of the recycled water. A careful engineering analysis is required to determine the necessary system changes and their cost.

The cost of a retrofit can vary dramatically, in one project, the retrofit cost for two golf courses located in close proximity to one another was about $25,000 for one and over $500,000 for the other. The reason was that the low cost retrofit was on a relatively new course in which the irrigation system had been laid out from a single water meter with a minimum of restrooms or other potable demands on the irrigation system. The more expensive system was for an old course which had about 14 small water meter connections scattered around its periphery. In addition, extensive replumbing was needed to separate potable uses from the recycled water system and supply adequate pressure.



The retrofit costs can be a cost of the project borne by the sponsoring agency or by the user. In some cases, the sponsoring agency can loan the users the cost of the retrofit and then recoup costs (without interest) by charging the user potable water rates. Potable rates are charged until the differential between recycled water rates and potable water rates times the volume used equals the cost of the retrofit. At that point, the user starts paying the lower recycled water rates.

If there are many users, the sponsoring agency will find it advantageous to offer help with the engineering aspects of the retrofit. This ensures that the retrofit is done correctly and does not restrict the operation of the entire system.

5.1.5 Provide Incentives for Dual Water Systems

The potential recycled water user must have incentives to install the required dual plumbing. State Law (Water Code Section 13555.3) requires dual plumbing of new construction where recycled water availability is planned under an adopted master plan or urban water management plan. Some incentives are automatically conferred and include the additional nutrient value of the nitrogen and phosphorus in the recycled water for irrigation uses and the general reliability of the supply in times of drought when potable supplies may be limited. Other incentives need to be economic since it is costly and time consuming to install dual water systems. For example, dual water systems require an additional level of care and introduce some operational constraints on the users. Providing economic incentives which make it worth the additional effort to the user usually offsets this nuisance factor. In addition to selling the recycled water at a lower unit price than potable water, the agency may also choose to fund the capital cost of retrofitting and recouping the cost of the investment over time from the user by adding a factor into the water bill. The availability of a master plan showing the planned routes for the distribution system also encourages cooperation from new developments.

5.1.6 Assure Availability and Quality

5.1.6.1 Availability of Water

The recycled water must be available in adequate quantities to service the needs of the user and must be delivered to the property line by the purveyor. The purveyor should also guarantee that the water will meet the appropriate health department requirements for each specified type of use or that potable water will be furnished in its stead. If there are time constraints on the availability of the water, delivery schedules are needed to assure that multiple users can each get the recycled water when they need it. The authority to apply those restrictions should be included in the ordinance. When appropriate, specific conditions on timing, maximum and minimum quantities and delivery rates may need to be included in each user's reuse permit or delivery contract. Recycled water agencies may provide these service standards by issuing operating manuals and Board of Directors-adopted administration codes.

5.1.6.2 Quality of Water

Recycled water is derived from municipal wastewater (sewage) by providing primary, secondary and usually tertiary treatment followed by disinfection, in order to remove the suspended solids, organic matter, and pathogens. Although this treatment process is capable of transforming a nasty looking and smelling waste material into a clear and useable water supply, there are some constituents of the wastewater that are not effectively removed by standard treatment processes. For example, there is usually a slight increase in total dissolved solids (often referred to as salinity) and limited removal of some heavy metals and some volatile/nonvolatile organic materials. For materials which are not easily removed in conventional treatment processes, industrial pretreatment programs are designed to reduce such materials to acceptable levels.

5.1.6.3 Salinity Management

From the user's standpoint, salinity (as represented by total dissolved solids, TDS) is the most critical characteristic of recycled water. If the TDS count is high, there is a good chance that specific chemical constituents and characteristics of the TDS such as hardness, chlorides, nutrients, sodium, etc. will also be high. Since TDS, or salinity, is not reduced through standard treatment and is very costly to reduce by processes such as reverse osmosis (RO) or ion exchange, it is best managed at the source.

The TDS of the area (usually the primary determinant of final TDS) water supply is often out of the control of the agency proposing the recycle project. However, selective distribution of alternative sources of water and identification of the collection system sewers with the lowest TDS will help assure that the TDS is as low as possible. Collection systems near the ocean are often old and infiltrated with salt water which can render the wastewater too high in TDS for practical reuse. Limiting the siting of new industries, which discharge high TDS effluents to sewers that bypass potential water reclamation plants, will also help control salinity. Some areas also regulate the type or location of water softener usage and regeneration to minimize the impact on the TDS of recycled water. For a more detailed discussion, see the draft Final Report of the *Southern California Salinity Management Study.* (MWD, July 1998.)

CASE STUDY
ESCONDIDO BRINE MANAGEMENT FEASIBILITY STUDY
EXAMPLE OF SALINITY REDUCTION

A Brine Management Feasibility Study was prepared by the City of Escondido (Escondido) in 1994. The purpose of the Feasibility Study was to develop a wastewater quality control program to maintain reclaimed water quality within established limits as required by both potential users and the regulatory agencies. The overall objective was to maximize use by making the water acceptable for as wide a range of reclamation practices as possible.

Water quality goals were established for the constituents of concern to meet the RWQCB's Basin Plan objectives and provide the flexibility to accommodate changing conditions in the future. The constituents of concern, the most restrictive Basin Plan objectives, and the established water quality goals are as follows:

Constituent (mg/l)	HARRF [1] Effluent Quality	Basin Plan Objectives [2]	Water Quality Goals
TDS	1037	1000	900
Chloride	240	300	190
Manganese	0.40	0.05	0.05
Fluoride	1.6	1.0	0.9
Boron	0.8	0.5	0.5

1 Hale Avenue Resource Recovery Facility
2 Escondido Creek Subbasin

Wastewater flow from Escondido and the Rancho Bernardo area of the City of San Diego is conveyed to the Hale Avenue Resource Recovery Facility (HARRF) for treatment. HARRF is located in the western part of Escondido and is jointly owned by both Escondido and San Diego. The sewer system for the community of Ranch Bernardo (RB) is divided into two distinct drainage areas, separated by Interstate 15 with runs generally in a north/south direction and divides RB into an east and west drainage area. The RB-East drainage is primarily residential, while the RB-West drainage contains several industrial discharges.

In 1994, San Diego began operation of the 1.0 million gallons per day (mgd) San Pasqual Aquatic Treatment Plant (Aqua III). Wastewater flow diverted to Aqua III is higher quality residential wastewater from RB-East. Aqua III includes secondary treatment in 24 aquaculture ponds containing water hyacinths followed by coagulation, settling, and mixed-media filtration. About half (0.5 mgd) of the flow is also treated with lime clarification, ultra-violet disinfection, reverse osmosis (RO), air stripping, and carbon adsorption. The waste discharge streams from Aqua III such as the RO reject, filter backwash, and pond solids are returned to the sewer system for treatment and disposal at HARRF.

Sampling of wastewater flows from RB was conducted by Escondido over a two-week period in May 1993. Separate samples were collected for RB-East and RB-West and tested for concentrations of TDS, fluoride, sulfate, boron, and manganese. The results of the sampling indicate that TDS concentration from RB during the sampling period ranged from about 1,100 to 1,600 mg/l for RB-East, while for RB-West the TDS concentrations ranged from about 1,600 to over 2,200 mg/l. The combined average from RB to HARRF was about 1,375 mg/l.

Automatic water softeners (AWS) were included as a potential source of significant discharges because of the salt brine solution that these water softeners discharge into the wastewater system. A survey of bulk salt sold within the study area from retail outlets was conducted to assess the significance of the volume of salt discharged from AWS to the wastewater system. As estimate was made of the percent of the total salt sold and used in the area tributary to HARRF. The results of this survey indicated an increase of TDS in the HARRF effluent of about 50 mg/l due to AWS.

There are four basin approaches used to identify the available options for control of discharges of the constituents of concern to HARRF. These alternative approaches include:

- ***Alternative 1*** - Allow discharges to sewers as currently exist and remove at HARRF;

- ***Alternative 2*** - Remove from the wastewater system at Point of Generation (POG);
  - Remove as liquid (piped brine collection system)
  - Remove as solid (evaporation)
  - Recycle
  - Implement production substitution

- ***Alternative 3*** - Eliminate source of discharge; or

- ***Alternative 4*** - Dilution with imported water to achieve desired reclaimed water quality

The alternatives for brine management were evaluated on a monetary and non-monetary basis. The monetary evaluation includes capital costs, O&M costs, as well as total annual costs. Non-monetary evaluation criteria include reliability, flexibility, ability to implement and public appearance.

The lowest cost alternative included removal of the brine discharges at the POG using separate brine collection system. This alternative also ranked high from a non-monetary viewpoint in terms of reliability, public acceptability, and flexibility. San Diego is pursuing construction of a brine collection system that satisfies State Ocean Plan requirements that will convey industrial discharges with high levels of TDS around the HARRF directly to the outfall system for discharge to the ocean. In addition, Escondido has developed restrictions on use of self-regenerative water softeners in areas tributary to HARRF.

5.2 PROVIDE INCENTIVES FOR WATER RECYCLING

In contrast to forcing users to accept recycled water, many agencies have found that establishing financial incentives can be effective in gaining user cooperation and support. Most incentives can be equated to financial incentives even if stated in abstract terms like the guarantee of an adequate water supply during times of drought.

5.2.1 The Role of Regional Water Supply Incentives

Financial incentives for development of a project can be established by a regional or statewide authority, when the unit cost of the water from the project is higher than the current price of water that the local agency is paying. Since the State and the regional supply agencies such as the MWD are charged with developing additional water supplies to serve the state's growing population, they are facing marginal costs of finding and developing new supplies. The marginal costs are substantially higher than the average cost of water in the state. By subsidizing local agencies with the potential to recycle water, the State or MWD can encourage the development of new water sources without the environmental, political, institutional, and economic costs of finding and developing new natural water supplies. The subsidies offered are often sufficient to provide the incentive for an agency to implement a water recycling project that would appear financially unwise for the agency to finance totally on its own (refer to page 1-10, "Local Programs That Promote Water Recycling").

User incentives, on the other hand, are designed to make the recycled water attractive to potential customers. Even if the customer has a suitable use for the recycled water that is available, he may have an aversion to using reclaimed water or recognize that having a dual system and following the DOHS regulations will require extra effort. By offering the recycled water at a discount under the price of potable water, the user can recognize a cost saving for the water and contribute to increasing the States total water supply, at the same time. For irrigation projects, the user also may benefit from the nutrients in the water, a factor that can represent an additional cost savings. These savings help offset the nuisance factor and encourage the user to see that appropriate steps are taken to comply with requirements and that the recycled water is used safely and beneficially.

5.2.2 The Role of Negative Incentives

Any agency with the power to sell water to customers has the authority to set the price for the recycled water at whatever rate it sees fit. However, if negative incentives are to be implemented, the agency must have the power to assess penalty fees on potable water supplies for failure of a customer to use recycled water when it is available at a reasonable price.

5.2.3 The Need for Financial Incentives

Financial incentives are usually in the form of a discounted price for recycled water when compared to the cost of potable water. The purpose of the incentive is to encourage a potential customer to choose recycled water in spite of the cost, inconvenience, or nuisance aspects of retrofitting their site and complying with regulatory requirements. A survey of 254 potential recycled water customers conducted in 1981 as part of the Orange and Los Angeles Counties Water Reuse Study (OLAC) determined that 80 percent of the potential users would voluntarily switch to recycled water, if there was a 20 percent discount from the domestic water price and the utility paid the on-site replumbing costs. Table 5-2 summarizes a more recent survey conducted by HYA Consulting Engineers in 1996. Actual projects have given larger and smaller discounts than 20 percent. Some projects have given no immediate discount if there were other extenuating circumstances, such as the need for increased reliability of supply, to prompt customer acceptance of the recycled water. In any specific situation, the sponsoring agency must identify all of the factors which are relevant to setting the price, including, the role of mandatory ordinances, the potential scarcity of alternative supplies, and a knowledge of the needs and interests of the potential customers.

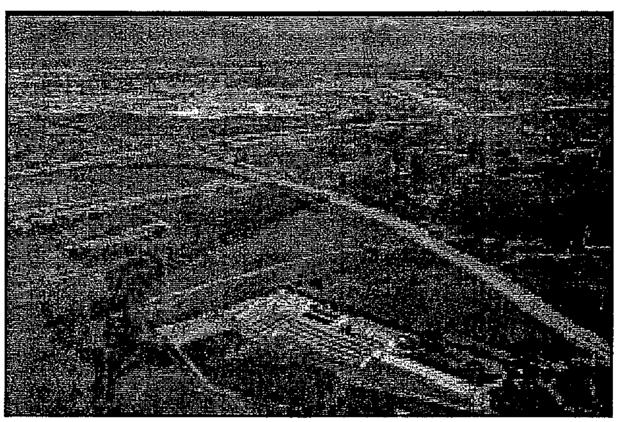


TABLE 5-2
MWD - RETROFIT FINANCING SURVEY
HYA CONSULTING ENGINEERS
July 17, 1996

		Total Reuse		Retrofit Funding						Financing Mechanisms						
				Connection and Meter			On-Site Work [1]									
Agency Name	Agency Type	Current (AF/Y)	Planned (AF/Y)	Agency Pays	User Pays (financed)	User Pays (not financed)	Agency Pays	Users Pays (financed)	User Pays (not financed)	Re-payment Procedure	Interest rate	Typical term	Recycled Water Cost (as % of potable cost)	Mandatory Use Ordinance	Agency Has User Agreements	Agency Has Rules and Regs [2]
Carslbad Municipal Water District	Retailer	3,360	11,200	X [3]		X [3]	X [3]		X [3]	N/A	N/A	N/A	95%	YES	NO	YES
Central/West Basin Mun. Water District	Wholesaler	15,700	122,000		X [4]			X [4]		Water Bills [5]	8%	10 yrs.	Typ. 80%	YES	YES	YES
El Toro Water District	Retailer	300	13,000				Not Determined						55%	NO	NO	NO [6]
Escondido, City of	Whol./Ret.	0	2,800	X			X			N/A	N/A	N/A	80%	YES	NO	YES
Irvine Ranch Water District	Retailer	11,407	11,407	X				X [7]		Water Bills [5]	0%	-	90%	YES	NO	YES
Las Virgenes Municipal Water District	Retailer	4,400	4,400	X				X		Water Bills [5]	0%	2 - 3 yrs	75%	YES	YES	YES
Long Beach Water District	Retailer	3,840	10,720	X					X	N/A	N/A	N/A	55%	NO	NO	YES
Los Alisos Water District	Retailer	2,500	2,500						X	N/A	N/A	N/A	37%	NO	YES	NO [6]
Los Angeles Dept. of Water & Power [8]	Retailer	1,800	100,000	X				X		Water Bills [5]	See footnote 8		80% - 100%	YES	YES	NO
Marin Municipal Water District	Retailer	700	1,100	X			X (B.P.onl		X	N/A	N/A	N/A	56%	YES	NO	YES
Orange County Water district	Wholesaler	3,300	4,500	X			X [9]		X [9]	N/A	N/A	N/A	80% - 90%	NO	YES	NO
Padre Dam Municipal Water District	Retailer	1,120	2,240	X			X			N/A	N/A	N/A	85%	YES	YES	YES
San Diego, City of	Retailer	0	8,600	X			X			N/A	N/A	N/A	90%	YES	YES	YES
Santa Margarita Water District	Retailer	1,300	2,600				Not Determined						100%	YES	YES	YES
Santa Rosa, City of	Retailer	11,000	20,000	X			X			N/A	N/A	N/A	FREE - 75%	NO	YES	NO
South Coast Water District	Retailer	980	1,500	X			X (rare)		X	N/A	N/A	N/A	80%	YES	YES	NO [6]

FOOTNOTES

1. ON-site work is defined as all work downstream of meter, including backflow preventor (BP).
2. Refers to any rules and regs other than Title 22 or Regional Board orders.
3. Carlsbad only provides retrofit financing to publicly-owned users.
4. Some users may elect not to finance the retrofit costs. In addition, C/WMWD sometimes pays the retrofit costs for users critical to the distribution system.
5. "Water bills" indicates user is charged potable water reate and difference is applied to pay off the retrofit loan.
6. Uses SOCRA rules and regs.
7. Retrofit costs are financed, but District applies Metropolitan rebate directly to loan balance.
8. Los Angeles Department of Water and Power has not determined an internest rate or maximum term. It is likely they will adopt a financing system similar to West Basin MWD.
9. In most cases user is responsible for retrofit costs. District will pay costs for critical users in financial need.

5.2.4 The Amount of the Financial Contribution

If retrofit costs are involved, a careful study of required changes in the plumbing system needs to be conducted by the design engineers. The retrofit process sometimes involves a significant upgrading of an old or dilapidated on-site distribution system. The analysis should evaluate whether the customer was going to need to redo his system in the near future anyway. If a redo was upcoming, cost sharing should be negotiated so that the project only pays the costs related to the change in water supply and not the full cost of replacing a worn out system. In some cases, the customer is actually required to pay for all retrofit costs, but the project sponsor provides the initial funding and is reimbursed through a higher recycled water price until the cost of the retrofitting is paid off.

5.2.5 Implementation of Financial Incentive Programs

Implementation is generally dependent upon the powers of the sponsoring agency. However, in most cases pricing policies and other incentive programs will be adopted by ordinance or resolution and incorporated into the administrative code.

5.2.6 Non-Monetary Incentives

The primary non-monetary incentive is the reliability or availability of reclaimed water when there are shortages of potable water. Of course, this incentive can also be converted into an economic incentive based on the value of the industrial product, irrigated crop, or commercial activity supported by the recycled water.

In some areas or for some users, there is also an incentive to "do the right thing" based on an accepted environmental philosophy that recycling is environmentally beneficial. This outlook will encourage certain potential users to accept recycled water even if no financial benefits would accrue to them. Helping to assure an adequate potable water supply for the community also is a non-monetary incentive. For some industries or commercial activities, there is good public relations value in showing they are environmentally responsible by accepting recycled water. To enhance the role of these subtle incentives, the sponsoring agency should conduct an effective public education and information program so those potential users recognize the environmental and public relations benefits of using recycled water.

5.3 WHY MANDATORY USE ORDINANCES?

Use of recycled water and installation of dual water systems can be required by ordinance. The Water Code (13550-13554) provides specific authorization for mandatory use ordinances. Most agencies have adopted some form of mandatory use ordinance, but generally do not rely upon it to force customers to be users. Experience has shown that use of incentives and a mutual commitment to problem solving is more effective in securing user commitment than mandatory use ordinances. The SWRCB Water Recycling Guidelines provide an example if a mandatory use ordinance and secondary and ordinance to be eligible for State Loans.

Recycled water has quality characteristics that sometimes require system adjustments. Those adjustments must be managed properly and safely to assure that it serves the needs of customers. A committed customer will investigate and solve problems; whereas, an uncommitted customer can find endless reasons why the product is not suitable or make claims of damage to crops, products or staff. This lack of confidence can effect the attitudes of others in the community and conceivably cause an otherwise worthwhile project to fail. Having the big stick in the background helps get the attention of the potential customer, but good public relations, combined with specific information, and examples/testimonials from other users will be essential to converting a skeptical potential user into a supporter of the project.

5.3.1 Adoption of a Mandatory Use Ordinance

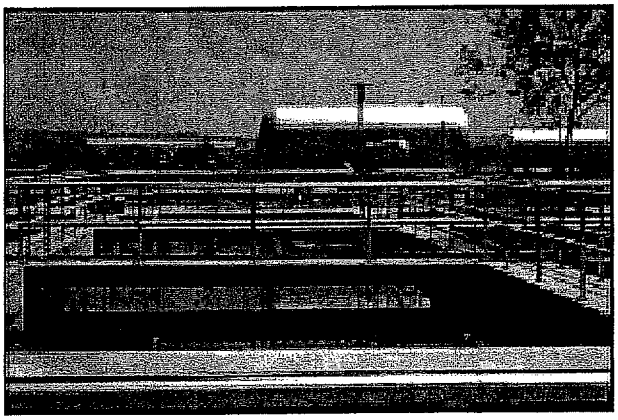
In order to have an ordinance mandating the use of recycled water under specified conditions, the sponsoring agency must have the authority to adopt it. Generally, a water purveyor has the authority but a wastewater agency does not. However, forcing the use of reclaimed water solely through the power of an ordinance can lead to lawsuits and does not necessarily enhance a good public education program. The support of the user is important because he has the ability in day-to-day operations to make it work or not. An alternative to making the use mandatory is to establish a price penalty on potable water if the recycled water is available at a reasonable price and the user chooses not to use it. For example, the West Basin Municipal Water District and Las Virgenes Municipal Water District have adopted an ordinance that specified a 50 percent increase in potable water costs for a user choosing not to be served by available recycled water.

5.3.2 Specification of Mandatory Use Conditions

A use ordinance must list the types of uses for which the recycled water is suitable. These can be generic groupings such as landscape irrigation or specific types of commercial activity, such as golf courses, cemeteries, parks, playgrounds, and school athletic fields. Types of uses recognized by the DOHS are listed in the proposed revisions to Title 22 along with the quality of water required to service each type of user. The ordinance should specify the minimum quantity requirements that qualify for mandatory use, as well as the type of use. The ordinance should also require that the user comply with the Title 22 and Title 17 requirements on uses contained in the California Code of Regulations and all other applicable requirements established by local, state or federal law.

5.4 KEY REFERENCES AND AGENCY CONTACTS

1) "Handbook on the Use of Recycled Water for Industrial/Commercial Cooling System," West Basin Municipal Water District, Central Basin Municipal Water District.



2) USGA Golf Course Textbook on Recycled Water

3) Videos - "Making Recycled Water Work Together," USBR and WBMWD/ CBMWD."

4) "Guidelines for the Onsite Retrofit of Facilities Using Disinfected Tertiary Recycled Water," CA-NV AWWA, 1997

Section 6

APPENDICIES

INDEX

Section 6.1

DEFINITIONS

Acre-Foot: A volume unit of measurement for water. One acre-foot equals approximately 325,900 gallons, enough to fill a football field to a depth of one foot or to supply the water needs of one to two families for a year.

Activated Carbon Adsorption: A process for removal of soluble components from water by absorbing them on the extensive surfaces of the carbon

Activated Sludge: A biological treatment process that involves the use of free floating aerobic microbes in a well-mixed reactor.

Advanced Wastewater Treatment: Any physical, chemical, or biological treatment process used to accomplish a degree of treatment greater than achieved by secondary treatment.

Avoided Cost: The cost of an activity or facility that could be *avoided* by choosing an alternative course of action. For example, avoided water supply costs are the costs of water supply that are avoided by water recycling which reduces the need for new supply projects.

Construction Financing Plan: The demonstration of the financial capability to design and construct a project.

Cost-Effective: When the present value of benefits exceeds the present value of costs.

Cost-Effectiveness Analysis: An analysis to determine which project alternative will result in the use of minimum total resources.

Costs: The resources needed for a course of action – in this case for Water Recycling Project implementation.

Denitrification: Part of a system to remove organic nitrogen from wastewater. Specifically refers to the conversion of nitrate/nitrite secondary treatment.

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Desalting (Or Desalination): Specific treatment processes, such as reverse osmosis or multi-stage flash distillation, to demineralize seawater or brackish (saline) waters for reuse. Also sometimes used in wastewater treatment to remove salts and other pollutants.

Direct Non-Potable Water Reuse: The direct discharge of suitably treated reclaimed water into a non-potable distribution system that provides service to customers who obtain their potable water from a separate system.

Direct Potable Reuse: The direct discharge of highly treated reclaimed water meeting all potable water standards into a potable-water distribution system. This practice has not adopted by or approved for any community in the United States.

Direct Potable Water Reuse: The use of reclaimed water treated to a sufficient degree that it is acceptable for drinking and direct discharge into a potable-water distribution system. The practice has not been adopted by or approved for any community in the United States.

Direct Reuse: When reclaimed water is put in a distribution system, including a reservoir, for delivery to a specified user.

Direct Use: The planned and deliberate use of treated wastewater for some beneficial purpose such as irrigation, recreation, industry, or potable reuse without being discharged to a raw water source.

Discount Rate: The rate used to calculate the present value of future benefits and costs.

Disinfection: The killing of waterborne fecal and patheogenic bacteria and viruses in potable water supplies or wastewater effluents with a disinfectant; an operational term that must be defined within limits, such as achieving an effluent with no more than 200 colonies fecal coliform/100 mL.

Economic Analysis:	The procedure to determine the total monetary costs and benefits of all the resources committed to a project, regardless of whom in society contributes them or who in society receives the benefits.
Eligible Water Recycling Project:	A water recycling project that is cost-effective based on the project objective when compared to the appropriate alternatives to achieve the objective. The project shall comply with applicable water quality standards, policies, and plans.
Escalation Rate:	The average rate of increase in the inflation-adjusted future cost of water supply.
Existing User:	An entity that currently exists or will exist before the completion of project construction and is using or would be expected to use fresh water if recycled water were not made available.
External Costs and Benefits:	An *external cost* is when one party, as a result of its actions, adversely affect another party either by reducing its productivity or well being, or by raising its costs. An *external benefit* is where one party beneficially affects another party either by increasing its productivity or its well being, or lowering its costs.
Financial Analysis:	The procedure to determine financial feasibility through the determination of expenditures and incomes of or other financial impacts on the agency implementing the project, recycled water users, or others affected.
Fixed Costs	Those that do not change as output level changes over the time horizon being analyzed. These costs typically include capital goods, land, and long-term contract commitments.
Future User:	An entity that currently does not exist and will not exist before of the completion of project construction.
Gray Water Reuse:	Reuse, generally without treatment, of domestic type wastewaters (other than toilet wastewaters) for toilet flushing, garden irrigation, and other non-potable uses.

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Incremental Costs and Benefits: The costs and benefits that occur due to a course of action (e.g., W.R. implementation) that would not occur otherwise. In other terms, incremental costs and benefits are the additional "increment" of costs and benefits from implementing Water Recycling Projects.

Indirect Non-Potable Water Reuse: The use of reclaimed water that had been discharged to receiving water, either surface or underground, which is drawn, generally after additional treatment, for distribution for non-potable purposes to customers who obtain their potable water from a separate system.

Indirect Potable Water Reuse: The advanced treatment of reclaimed water for augmentation of a local surface or underground potable water supply in which the identity of the reclaimed water is lost.

Indirect Reuse: The domestic or industrial use of treated (or, in some instances, untreated) wastewater which is discharged into fresh surface or underground waters and is used again in its diluted form.

Industrial Wastewater: Wastewater derived from industrial sources or processes.

Inflation: The rate of change in a price index (e.g., the Consumer Price Index) over a certain period of time that reflects a general increase in *all* prices so that relative prices of different goods and services remain the same. Annual inflation, for example, reflects the change in the purchasing power of a dollar over the course of a year.

Life-Cycle Analysis: Examines the costs and benefits of an action (e.g., Water Recycling Project) over its entire expected life span.

Local Public Agency: Any city, county, district, joint powers authority, or any other local public body or political subdivision of the state created by or pursuant to state law and involved with water or wastewater management (based on 1988 Bond Law)

Marginal Cost: The additional cost incurred by producing one more unit of output (e.g., the additional costs of supplying one more acre-foot of water).

Market Price:	Determined in a *market*, which is where individuals, firms or other organizations come together to exchange goods and services. Markets can take many forms, including dealerships, financial asset and stock exchanges, stores, bulletin board listings, and brokerages.
Municipality:	Municipality shall have the same meaning as in federal Clean Water Act (22 U.S.C. Sec. 1251 et. Seq.) and shall also include the state or any agency, department, or political subdivision thereof (based on 1984 Bond Law).
Municipal Wastewater:	Wastewater derived from domestic, commercial, and industrial sources.
Net Present Value:	The present value of benefits minus the present value of costs. Present value refers to the value of a cost or benefit *today* that will be incurred or accrued sometime in the future. The present value of a cost or benefit is determined by discounting the future cost or benefit utilizing a discount rate.
Nitrification:	Part of a system to remove organic nitrogen from wastewater, specifically refers to the conversion of organic nitrogen (principally ammonia) to nitrate.
Non-Potable Reuse:	The use of reclaimed water for non-potable purposes, such as farm or landscape irrigation, or industrial uses.
NPDES:	National Pollutant Discharge Elimination System
Ozonation:	The process of contracting water, wastewater, or air with ozone for purposes of disinfection, oxidation, or odor control.
Period of Analysis	The period over which the cost-effectiveness of the Water Recycling Project is analyzed, generally 20 years.
Potable Reuse:	The use of reclaimed water in water supplies which are fit or suitable for drinking and ingestion; usually taken to mean treated wastewater that goes directly to the water treatment plant.

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Potable Water:	Water of high quality intended for drinking, cooking, and cleaning. This grade of water would conform to the drinking water quality requirements of State and Federal regulatory agencies (Pronounced with long O).
Pretreatment	Any water or wastewater treatment process that precedes primary treatment; may include aeration, equalization, pH adjustment, grit removal, screening, skimming, comminution, or other processes.
Primary Treatment:	Removal of suspended solids, both fine and coarse, which either float or settle out from raw sewage.
Project Useful Life Span:	The life span of a *device* is its remaining physical or productive lifetime. It begins when the device is acquired and ends when the device is retired from service. *Project* life span is the remaining physical or productive lifetime of devices (or assets more generally) required for a project.
Reclaimed Water:	Municipal, industrial, domestic, or agricultural wastewater, and naturally impaired ground and surface waters that, as a result of appropriate treatment, is suitable for subsequent beneficial use. Historically, reclaimed water was referred to as useable water derived from municipal wastewater.
Recycled Water:	Reclaimed water in reuse.
Recycling:	A type of reuse, usually involving running a supply of water through a closed system again and again. New legislation in 1991 legally equates the term *"recycled water"* to reclaimed water.
Reverse Osmosis:	An advanced method used in water and wastewater treatment which relies on a semipermeable membrane to separate the water from its impurities. An external force is used to reverse the normal osmotic flow, resulting in movement of the water from a solution of higher solute concentration to one lower in concentration.

Secondary Treatment:	Generally, a level or treatment that produces removal efficiencies for biochemical oxygen demand (BOD) and suspended solids (SS) of ≥ 85%. Sometimes used interchangeably with the concept of biological wastewater treatment, particularly the activated sludge process.
Sensitivity Analysis:	The process where the assumptions of analysis are tested to determine how much influence they have on the results. In other terms, "How sensitive are the results to alternative assumptions?"
Sunk Costs:	Costs that have already been incurred and are not reversible. For example, most engineering and design costs are sunk once they have been paid for. Unlike land or equipment, the design cannot usually be sold at a later time (if the design can be sold, then it is not sunk).
Tertiary Treatment:	The treatment of wastewater beyond the secondary or biological stage. Includes filtration or the removal or nutrients, such as phosphorous and nitrogen, and a high percentage of suspended solids.
Variable Costs:	The costs that change in response to changes in level of output by a firm. These costs often include energy, labor, chemicals, and supplies.
Wastewater Reclamation:	Treatment and management of municipal, industrial or agricultural wastewater to produce water of suitable quality for additional beneficial uses.
Wastewater:	Water that has been previously used (by a municipality, industry or agriculture) and has suffered a loss of quality as a result. Wastewater is generally over 99.95 percent water and 0.03 to 0.05 percent waste.
Water Reclamation:	The recovery of wastewater for useful purposes through treatment processes and subsequent return to either a surface or groundwater source.
Water Recycling or Reuse:	Used synonymously throughout the paper, to describe the use of reclaimed water for beneficial uses, both potable and non-potable.

Willingness to Pay:	The amount an individual would be willing to pay if he or she could obtain the item by making a payment. The maximum amount he would be willing to pay for the item measures its value to him in monetary terms.
Willingness to Accept:	The amount one would have to pay the individual if he or she could be induced by a payment to go without the item. The minimum amount that he should be willing to accept to forego the item is an alternative monetary measure of its value (alternative to willingness to pay).

Section 6.2

EXAMPLE PF WATER RECYCLING PROGRAM IN AN URBAN WATER MANAGEMENT PLAN

EAST BAY MUNICIPAL UTILITY DISTRICT, 1996

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EXCERPTS FROM...

Urban Water Management Plan

February 1996

EAST BAY
MUNICIPAL UTILITY DISTRICT

Chapter V
Current Water Reclamation Program

Reclaimed water is defined in the California Water Code as "water which, as a result of treatment of waste, is suitable for direct beneficial use or a controlled use that would not otherwise occur."

Water reclamation is an integral part of EBMUD's water supply management policies because any demand met with reclaimed water represents a reduction in demand met with high quality potable water. The benefits of reclaimed water are that it delays/eliminates the construction of additional facilities for high quality potable water and that fewer restrictions are required during drought. The District has explored the possibility of large-scale wastewater reclamation in recent years. However, opportunities for water reclamation are limited by the high cost of new facilities such as pipelines, pumping plants and treatment plants, and the distance between the sources of wastewater within the District's service area and larger potential users.

OFFICE OF RECLAMATION

To centralize and expand its water reclamation projects, EBMUD's Board of Directors approved the formation of an Office of Reclamation in 1988 within the Wastewater Department. Since 1985 the Office of Reclamation has grown from a staff of one person to a staff of five.

The initial goal of the office was to expedite reclamation projects in response to the 1987-88 drought. However, the current goal of this office is to develop and implement reclaimed water projects throughout the District in order to reduce the demand on high quality drinking water supplies. The District now provides reclaimed water to seven large irrigation customers and one large industrial customer. Potential reclamation projects planned for the future are described in Chapter VI of this Plan.

WATER RECLAMATION CONSIDERED AS AN ELEMENT OF THE WATER SUPPLY MANAGEMENT PROGRAM

Since the mid-1960s, EBMUD has conducted several water reclamation studies. At first, reclamation was considered primarily as a means of reducing wastewater discharges to San Francisco Bay. The more recent emphasis in water reclamation has expanded to reducing demand on drinking water supplies and increasing reliability of water supply during drought.

On October 26, 1993, EBMUD's Board of Directors adopted the Water Supply Management Program (WSMP) which included water reclamation as a key element. Figure V-1 summarizes several projects identified in the water reclamation element which are now complete. This figure also identifies their respective projected annual water savings in 2020.

Water reclamation projects completed through 1995 were selected based on their favorable economics. The lower cost of reclaimed water was an economic incentive for the user to convert to reclaimed water. The District priced reclaimed water so that project capital, operation and maintenance costs are repaid over the life of the project (usually 20 years). Prices were established separately for each project, and were rounded to a percentage of potable water costs. A backup potable water supply was provided for emergencies when reclaimed water may be temporarily interrupted.

The District's existing and adopted projects are summarized in the following paragraphs.

PROGRESS ON EXISTING AND ADOPTED PROJECTS

EBMUD Wastewater Department Activities. In 1971, the District constructed the Process Water Plant at its main Wastewater Treatment Plant to provide tertiary treatment of wastewater for on-site process and washdown uses. This plant has a capacity to treat one MGD. Secondary treated plant effluent is also used to irrigate decorative landscaping at the plant. The average total annual use is 4.2 MGD.

Existing Reclamation Projects

Figure V-1

Project	Description	Status	2020 Water Savings (MGD)	2020 Water Savings (Acre-foot)	Unit Cost ($/AF)
EBMUD Wastewater Department Activities	Secondary effluent for process water, landscape irrigation and washdown at the facility	Standard District practice	4.2		
EBMUD Potable Water Filter Plants*	Reclaimed backwash water from District potable water filter plants	Standard District practice	4.7		
Richmond Golf Course	Secondary effluent from West County Wastewater District for irrigation of the Richmond Golf and Country Club	Service began in 1984	0.16	149	256**
Galbraith Golf Course	Secondary effluent from the San Leandro WPCP for irrigation of the Galbraith Golf Course in Oakland	Service began in 1988	0.24	244	567‡
Alameda Golf Complex	Expansion of service from the San Leandro Reclamation Facility to serve two 18-hole golf courses at the Alameda Golf Complex and median landscaping along Harbor Bay Parkway	Service began in 1991	0.42	391	567‡
Lake Chabot Golf Course*	Use of raw water from Lake Chabot to irrigate Lake Chabot Golf Course	Service began in 1991	0.14	139	1507‡
Willow Park Golf Course*	Use of raw water from Lake Chabot to irrigate Willow Park Golf Course	Service began in 1991	0.09	102	498‡
CALTRANS/LAVWMA Freeway Landscape Irrigation	Secondary effluent from Livermore-Amador Valley Water Management Agency to irrigate freeway landscaping in Castro Valley, Hayward, San Leandro, San Lorenzo and Union City	Service began in 1994	0.12	136	102**
EBMUD/Chevron Oil Refinery Cooling	Secondary effluent from West County Wastewater District receiving tertiary treatment in District facilities for reuse in the Chevron refinery's recirculating cooling tower	Service began in 1995	4.7	5,000	800‡

* These projects are not reclamation projects in the strict sense, but they reduce demand on the District's potable water supply.
** District cost only.
‡ O&M and capital cost annualized over 20 years.

Richmond Golf Course. In 1984, the West County Wastewater District (WCWD) began supplying reclaimed water for irrigation to the Richmond Golf and Country Club. One hundred and fifty acres are irrigated, resulting in an estimated average consumption of 0.16 MGD. Peak monthly use during the irrigation season has reached 14 MG. As water purveyor, EBMUD was instrumental in implementing this project and is responsible for overseeing its operation.

Major reasons for the relatively low cost of this project are the close proximity of the wastewater treatment plant (two miles) to the customer and the availability of an existing abandoned pipeline, which is used for most of this distance. In addition, the high quality of WCWD effluent and the reliability of the treatment processes at this plant ensure that the reclaimed water meets Department of Health Services (DOHS) coliform standards for irrigation use with no additional treatment, although a standby chlorination unit is immediately available.

Galbraith Golf Course. In July 1988, the District constructed the San Leandro Reclamation Facility (SLRF) to serve reclaimed water to the Galbraith Golf Course. The golf course is temporarily closed but a new and improved course will be completed within 5-10 years. The SLRF delivered an average of 0.24 MGD of secondary effluent from the San Leandro Water Pollution Control Plant to the golf course. The SLRF includes a high head pumping station, and chlorination, dechlorination and surge control systems.

Alameda Golf Complex. In July 1991, the District completed the Alameda Reclamation Project as an extension of the SLRF to include the Alameda (Chuck Corica) Golf Complex and median landscaping along Harbor Bay Parkway. Facilities include minor SLRF control modifications and installation of just over three miles of pipeline. The project delivers an average of 0.39 MGD to the Golf Complex and 0.03 MGD for median landscaping at the nearby Harbor Bay Parkway .

CALTRANS/LAVWMA. In November 1995 EBMUD completed the Caltrans/LAVWMA reclamation project which supplies up to 0.12 MGD of secondary treated wastewater for the irrigation of freeway landscaping in portions of Castro Valley, Hayward, San Leandro, San Lorenzo and Union City. The reclaimed water is supplied by the City of Livermore and the Dublin San Ramon Services District wastewater treatment plants. The facilities consist of two pump stations.

Chevron Oil Refinery. The Chevron Oil Refinery Project is the largest single potential user of reclaimed water in the District's service area, and is the largest District reclamation project built to date. Facilities include a tertiary treatment plant (the North Richmond Water Reclamation Plant) with a 5.4 MGD capacity, and approximately 5 miles of supply pipeline. Details of this project are summarized in Figure V-2. This project, completed in 1995, reduces the potable water demand by 4.7 MGD. This large demand, and the refinery's close proximity to the wastewater source contribute to the economic feasibility of this project.

Total project cost was $31 million. Approximately $23.5 million was funded through low-interest state loans.

The crucial difference between this project and the golf course irrigation projects previously described is the need to satisfy the customer's more stringent water quality requirements. When using reclaimed water in recirculating cooling towers, it is first necessary to remove contaminants that cause scaling, corrosion, and fouling of heat exchangers. This is accomplished by the addition of chemicals in advanced wastewater treatment (AWT) processes. For the Chevron Oil Refinery Project this includes the addition of lime and soda ash to the water for removing calcium, magnesium and phosphorus, which contribute to scaling. In addition, the water is pH neutralized, sand filtered, and chlorine disinfected before delivery to the customer.

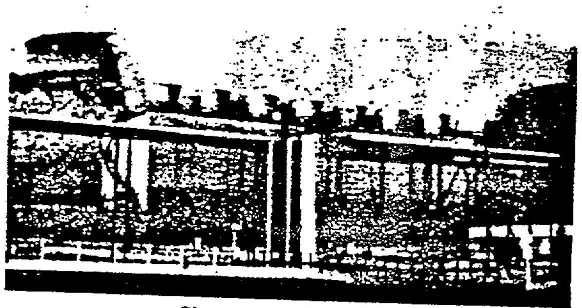
OTHER PROJECTS ADMINISTERED BY THE OFFICE OF RECLAMATION

Three of the existing reclamation projects do not use treated wastewater, but do use water that results in the reduction of demands on the District's potable water supply.

Filter Plant Washwater Reclamation. Facilities for reclaiming filter backwash water from most of the District's filter plants were constructed in the late 1970's in order to comply with federal discharge requirements. The National Pollutant Discharge Elimina-

EBMUD-Chevron Reclamation Project

Figure V-2



Chevron Cooling Towers

Community Involvement

- Liason with Richmond area through a Project Advisory Committee.
- Job recruitment focused in project area.
- $300,000 program to minimize neighborhood impacts.

Chronology

Early 1980's: Initial EBMUD-Chevron communications.
1985: Feasibility study and pilot plant proposed.
1987: Pilot plant project successfully completed.
1989: Environmental Impact Report certified by EBMUD.
1990-91: Design of plant.
1992-95: Construction of plant.
1995: Project startup.

Funding

Use of low-interest state loans and fees paid to EBMUD's Water Conservation and Development Fund financed the North Richmond treatment plant.

Water Savings

Conserves high-quality drinking water for EBMUD customers by reducing present refinery use of 11 million gallons per day by nearly half.

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tion System (NPDES) permit required the majority of suspended solids to be removed from the washwater prior to discharge into a receiving stream. Rather than discharge this wastewater, the District treatment plants instead recycle it, resulting in a net gain in potable water supply. The treatment plants operate sedimentation facilities to collect solids from the wash water and recover the clarified overflow which is then recycled through the potable water treatment process. The operation of filter plant reclamation facilities saves the District approximately 4.7 MGD.

The ability to treat and reclaim about 5 MGD of washwater at Orinda Filter Plant became available in 1988; however, because direct discharge of washwater to the San Pablo Creek replenishes the San Pablo Reservoir and becomes available for use at the Sobrante and San Pablo Filter Plants, no additional water savings will be realized. Facilities at Orinda will allow reclaimed water to be used at the filter plant, although normal discharge will be to the creek.

Lake Chabot Golf Course. This project, completed in 1991, provides approximately 0.14 MGD of water to irrigate the City of Oakland's Lake Chabot Golf Course. Facilities include a pump station, 9,500 feet of supply pipeline and a surge tank/storage reservoir. Since the water is drawn directly from Chabot Reservoir, which is a standby terminal reservoir of EBMUD not connected to the distribution system, demand is reduced from the potable water supply. In addition, by reducing the demand for potable water, this project eliminates the need to construct the proposed Peralta No. 2 potable water reservoir.

Willow Park Golf Course. This project, completed in 1991, withdraws 0.09 MGD of water from Lake Chabot to irrigate the Willow Park Golf Course. Facilities include a submersible pump station and 8,500 feet of pipe. Like the Lake Chabot Golf Course project, raw water is also taken from the Chabot Reservoir, reducing the demand from the potable water supply.

The potential for future water reclamation is discussed in Chapter VI of this Plan.

Chapter VI
Potential Future Water Reclamation

WATER RECLAMATION FUTURE PLANNING

The District recognizes that reclamation is important for a complete and balanced water supply management program and has incorporated reclamation planning in the Updated Water Supply Management Program (WSMP) and Water Supply Improvement Projects Environmental Impact Statement and Environmental Impact Report (EIS/EIR).

The WSMP incorporated findings of the Draft Water Reclamation Master Plan, which identified potential sources and uses of reclaimed water, estimated water reclamation demand, and identified potential water reclamation projects in the District's service area. Potential sources of nonpotable water considered included wastewater treatment plant effluent, groundwater, and local surface water. The draft Master Plan focused on reclaimed water from wastewater treatment plants, as this has been determined to be the most feasible and reliable nonpotable water supply option. A list of the wastewater treatment facilities in the District's service area is provided in Figure VI-1.

The District is preparing a Water Reclamation Implementation Plan (WRIP) which is a comprehensive plan for implementing future water reclamation projects and builds on the information and projects developed in the draft Master Plan. Objectives of the WRIP are outlined as follows:

- Establish policies governing the provision, use and price of nonpotable water;
- Identify institutional arrangements that must be reached with other wastewater agencies who supply water for projects outside the District's wastewater service area (SD-1);
- Identify specific proposed projects, including associated costs, projected water savings and implementation schedules; and
- Outline a community outreach program to support the District's water reclamation efforts.

Wastewater Treatment Facilities in EBMUD Service Area

Figure VI-1

FACILITY	CAPACITY (MGD)
EBMUD Special District No. 1	168
City of San Leandro	7.6
Oro Loma Sanitary District	20
Dublin San Ramon Services District	11.5
Central Contra Costa Sanitary District	45
Crockett Valona Sanitary District	0.3
Rodeo Sanitary District	1.1
City of Hercules	0.375
City of Pinole	4.2
City of Richmond	16
West Contra Costa Sanitary District	9.5
LAVWMA Export Facilities	21
Pinole/Hercules/Rodeo Outfall	10
EBDA Outfall	189

RECLAIMED WATER MARKET ASSESSMENT

Potential to use reclaimed water within the District's service area was determined by assessing user interest, evaluating the suitability of reclaimed water for various uses, and estimating present and future reclaimed water demand quantities.

Potential sources of reclaimed water were identified in three ways: 1) from a review of readily available information, such as maps and aerial photographs showing irrigated areas, 2) from previous District studies, such as those done in the San Ramon Valley area in 1985 and 1988, as well as the 1979 Reclamation study, and 3) from customer account information in the District's computerized Customer Information System (CIS).

Four hundred potential users were identified representing a variety of customer uses. The 20 most promising candidates (based on water demand, quality requirements, and stated interest) received a site visit.

Future potential demand was based on the estimate of future development projected by the Association of Bay Area Governments. Relatively large proposed or potential developments (more than 300 homes) were identified for 11 jurisdictions or planning areas. Future potential demand was estimated for landscape irrigation uses only, because industrial development has remained relatively constant in the service area and no new major industrial developments are planned.

This market assessment in the draft Master Plan identified potential demand of nearly 10 MGD for existing customers and a potential demand of about 5 MGD for future developments. The WSMP evaluated this information, along with other water supply options, and selected a program that included a goal of 8 MGD of additional reclaimed water supply by 2020. Potential customers for this 8 MGD demand were grouped into seven zones. Figure VI-2 summarizes the potential demand by individual zone. These zones are shown in Figure VI-3.

POTENTIAL PROJECTS

The reclaimed water market assessment identified and documented the potential demand in the seven zones. By matching these potential users with nearby reclaimed water sources, projects were developed for six of the seven zones. Five of the projects are refinements of those first developed in the draft Master Plan. The sixth project was developed subsequent to that plan. These six projects will serve a total of 103 users. Combined demand of these potential users, which represent existing potable water customers as well as selected future development, will be 9.0 MGD.

The project alternatives developed in the Draft Master Plan have now been consolidated into the five projects of the Draft WRIP. These projects either include most of the customers considered under the original Draft Master Plan alternatives, or add new customers.

Figure VI-4 lists the potential projects, total annual water demand and capital cost for each project. Landscape irrigation (golf courses, cemeteries, parks, school grounds, residential landscape, etc.) represents the largest category at about 75 percent of the total combined use. Refinery cooling accounts for approximately 13 percent of the total demand and the remaining 12 percent is comprised of other industrial uses.

The Draft WRIP prioritized the six reclamation projects for implementation using a ranking system based on four criteria: Economic, Environmental, Institutional, and Operational. As a result of ranking, projects slated for high priority implementation include:

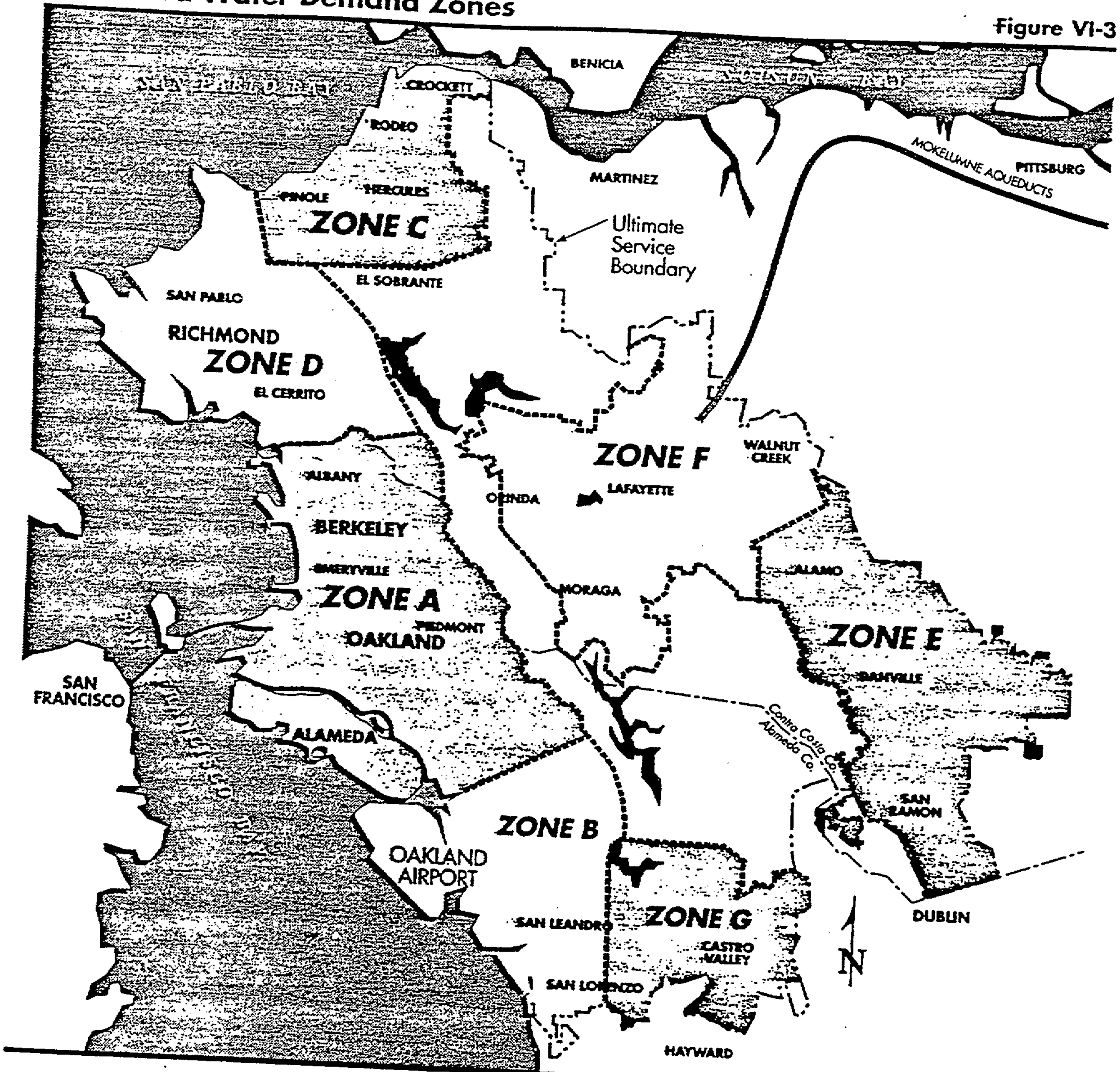
Potential Reclaimed Water Demand by Zone Figure VI-2

ZONE	COMMUNITY	EXISTING DEMAND (MGD)	FUTURE DEMAND (MGD)
A	Oakland/Berkeley	2.3	—
B	Alameda/San Leandro	0.85	0.43
C	Pinole/Hercules/Rodeo	2.1	0.24
D	Richmond/West Contra Costa	1.2	0.43
E	San Ramon Valley	2.4	2.9*
F	Central Contra Costa	0.92	0.43
G	Castro Valley	0.16	0.67
TOTAL		**9.7**	**5.1**

*2.5 MGD outside the District's Ultimate Service Area.

Reclaimed Water Demand Zones

Figure VI-3



- San Ramon
- Hercules/Pinole/Rodeo - Phase I
- Central Contra Costa

Projects slated for medium priority implementation include:

Hercules/Pinole/Rodeo - Phase II

Oakland/Berkeley

San Leandro/Alameda

Projects slated for low priority implementation include:

- Richmond

With the exception of one project (Oakland/Berkeley), all of the proposed projects above will be supplied from wastewater sources outside the District's wastewater service area.

SCHEDULE FOR IMPLEMENTATION

An implementation schedule was developed in the Draft WRIP. The three high priority projects will be completed by 2002, resulting

Potential Water Reclamation Projects[1]

Figure VI-4

ZONE	PROJECT	USE TYPE*	AVERAGE DEMAND	CAPITAL COST[2] (Million $)	UNIT COST[3] ($/AF)
A	Oakland/Berkeley	IRR/IND	1.2	12.4	453
B	San Leandro/Alameda- Phase III	IRR/IND	0.8	8.8	616
C	Hercules/Franklin Canyon- Phase I	IRR/IND	0.4	3.8	638
C	Hercules/Franklin Canyon- Phase II	IRR/IND	2.0	19.6	667
D	Richmond	IRR/IND	0.7	11.8	N/A
E	San Ramon Valley	IRR	2.8	23.4	438
F	Central Contra Costa (4)	IRR	1.1	13.4	553
Totals			9.0	93.2	

(1)As developed in the WSMP.
(2)Preliminary estimate in 1994 dollars
(3)30-yr. gross unit cost
(4)Not included in 8 MGD identified in WSMP
* IRRigation/INDustrial

in total potable water savings of 4.5 MGD. A more lengthy schedule will be used for the three medium priority projects, with completion scheduled for 2008. Total potable water savings for these five projects will be 8.3 MGD. Only if further potable water savings are required to meet the goal of the WSMP will the single low priority project (Richmond) be built, with a tentative completion date for 2009.

The estimated capital cost for completing the high and medium priority projects is $81.4 million (1994 dollars). This cost estimate and schedule will be updated annually as projects become further defined.

DISTRICT GUIDELINES

The District's reclamation program was initially developed through the formulation of guidelines regarding reclaimed water pricing (see Figure VI-5). In 1988, guidelines were established which stated that reclaimed water would be used when it is available and appropriate for the intended use. Under the guidelines, reclaimed water may be priced so that when combined with connection charge revenues, all District costs will be recovered over the life of the project. In addition, this price resulted in no net increase in the overall cost to the user for water. Project development depended on voluntary participation by customers, and individually negotiated customer agreements.

Existing reclamation guidelines have served the District well to date. However, as the number of nonpotable water customers increases from the existing 8 to over 100, the administrative burden of individually negotiated customer agreements will become unacceptable.

Recent political developments may further encourage reclaimed water use. In 1991, the Board of Supervisors of Contra Costa County enacted an ordinance requiring all new development projects within the County larger than two acres, or greater than 20,000 square feet, to refer to its water or wastewater service provider who may require a separate plan to utilize nonpotable water where appropriate as a condition of service.

In order to fairly implement the expanded water reclamation program and ensure that the District meets its WSMP water reclama-

Guidelines on Reclaimed Water

Figure VI-5

THE USE OF RECLAIMED WATER IS ENCOURAGED TO:

- Maximize the efficient use of the existing potable water supply system by supporting the development of reclaimed water projects.
- Substitute reclaimed water, when available, for potable water in non-potable applications (irrigation, process cooling, etc.).

tion goals, the following policy revisions have been developed and are being considered by the District:

- ***Nonpotable Water Policy*** – The revised Nonpotable Water Policy would require that nonpotable water be used for nondomestic purposes when and where feasible. It will also include a discussion of dual plumbing requirements for new construction. Charges would be established for customers who refuse to use nonpotable water when it is feasible.

- ***Uniform Price Policy*** – Nonpotable rates and charges will be incorporated into the District's existing Schedule of Rates and Charges. The rates will be reviewed and updated annually.

- ***Cooperative Planning/Project Agreements*** – Cooperative agreements to develop a joint project with a wastewater agency should be pursued when the District's service boundary does not encompass the wastewater agency's entire service area.

- ***Supply Agreements*** – Supply agreements outlining the roles and responsibilities of the District and a wastewater agency for a District-only project should be pursued when the District's service boundary encompasses the wastewater agency's entire service area.

Section 6.3

RECYCLED WATER (NON-POTABLE UTILITY SERVICE REQUIREMENTS)

EAST BAY MUNICIPAL UTILITY DISTRICT, 1996

DRAFT

EBMUD

Policy 73

NONPOTABLE WATER

EFFECTIVE 09 APR 96

SUPERSEDE 24 NOV 87

IT IS THE POLICY OF THE EAST BAY MUNICIPAL UTILITY DISTRICT TO:

Require that customers of the East Bay Municipal Utility District ("EBMUD" or "District") use nonpotable water for nondomestic purposes when it is of adequate quality and quantity, available at reasonable cost, not detrimental to public health and not injurious to plant life, fish and wildlife. When nonpotable water satisfying these conditions is made available to the customer, the use of potable water for nondomestic purposes may constitute a waste and unreasonable use of water within the meaning of Section 2 of Article X of the California Constitution and is prohibited.

Findings Related to Use of Nonpotable Water

In its Updated Water Supply Management Program the Board of Directors of EBMUD determined that existing water supplies will not adequately accommodate existing and future demand within the District's Ultimate Service Boundary. Nonpotable water resources, including the wastewater discharged to the San Francisco Bay from EBMUD and other Bay Area treatment plants, could provide a safe and effective water supply alternative for nonpotable purposes, extend the limited potable water supplies of the District, assure customers of a more reliable water supply during periods of drought, reduce wastewater discharges to the Bay, and provide EBMUD with greater flexibility to meet instream needs in the American and Mokelumne River watersheds. The State Legislature has also determined that the use of potable domestic water for certain nonpotable uses may constitute a waste or unreasonable use of water if recycled water is available which meets specified conditions. (Water Code section 13550 et seq.)

Definitions

Nonpotable Water. All reclaimed, recycled, reused, or untreated water supplies that meet the conditions set forth in the California Water Code, Section 13550 and are determined by the District to be suitable for nondomestic purposes and feasible for the particular intended use.

Nondomestic Uses. For purposes of this policy, " nondomestic uses" shall mean all applications except drinking, culinary purposes and the processing of products intended for direct human consumption.

Mandated Uses of Nonpotable Water

Customers may be required to use nonpotable water for their nondomestic needs which may include, but are not limited to, the following:

- irrigation of cemeteries, golf courses, playing fields, parks, and residential and nonresidential landscaped areas;

- commercial and industrial process uses; and
- toilet and urinal flushing in nonresidential buildings.

Determination of Feasibility of Nonpotable Water

In determining whether nonpotable water is feasible for a particular nondomestic use, the District shall consider the following factors:

- Whether the nonpotable water may be furnished for the intended use at a reasonable cost to the customer and the District.
- Whether the nonpotable water is of adequate quality for the intended use and does not require significant additional on-site treatment beyond that required for potable water.
- Whether the use of nonpotable water is consistent with all applicable federal, state, and local laws and regulations.
- Whether the use of nonpotable water will not be detrimental to the public health and will not adversely affect plant life, fish and wildlife.

Regulations Governing Nonpotable Service

The regulations governing nonpotable water service and the rates therefor shall be determined by the Board of Directors and published in the Regulations Governing Water Service and Schedule of Rates and Charges for Customers of East Bay Municipal Utility District.

Water Reclamation Master Plan

The District shall prepare, and periodically update, a Water Reclamation Master Plan (WRMP) for evaluating the potential for nonpotable water use within the District service area. The WRMP shall designate Water Reuse Zones within which nonpotable water service shall have been determined to be reasonably available.

Nonpotable Water Service Agreements

Where implementation of the Policy requires agreements with other agencies, such agreements shall, wherever possible, have a term of 30 or more years and shall include provisions governing facilities operation and maintenance responsibilities. Customers receiving nonpotable water service pursuant to an agreement entered into prior to January 1, 1995 shall be governed by the nonpotable water service regulations and rate schedule upon termination or expiration of those agreements.

Authority

Resolution No. 32981-96, April 9, 1996

Reference

Regulations Governing Water Service and Schedule of Rates and Charges for customers of East Bay Municipal Utility District.

Water Reclamation Master Plan

SECTION 30

NONPOTABLE WATER SERVICE

In furtherance of District Policy No. 73, these regulations identify the types of water uses for which nonpotable water is appropriate; the factors considered in determining the feasibility of nonpotable water service; and the procedure for notification to applicants and customers that nonpotable water use is required.

DEFINITIONS

Feasible. Nonpotable water service shall be feasible if the District determines that:

- Nonpotable water may be furnished for the intended use at a reasonable cost to the customer and District.
- Nonpotable water is of adequate quality for the intended use and does not require significant additional on-site treatment beyond that required for potable water.
- The use of nonpotable water is consistent with all applicable federal, state and local laws and regulations.
- The use of nonpotable water will not be detrimental to the public health and will not adversely affect plant life, fish and wildlife.

Dual Plumbing. The installation of separate facilities for the distribution of potable and nonpotable water service. These facilities may include distribution piping from the water service main or water supply source to the water service meter, as well as facilities on the customer's side of the water service meter.

Nondomestic Uses. For purposes of this section, "nondomestic uses" shall mean all applications except drinking, culinary purposes, and the processing of products intended for direct human consumption.

Nonpotable Water. All reclaimed, recycled, reused, or untreated water supplies that meet the conditions set forth in the California Water Code, Section 13550 and are determined by the District to be suitable for nondomestic purposes and feasible for the particular intended use.

Retrofits. The conversion or modification of existing water service facilities such that they are suitable for nonpotable water service.

SECTION 30

NONPOTABLE WATER SERVICE
(Continued)

Water Reclamation Master Plan (WRMP). The WRMP is prepared by the District, and periodically updated, to evaluate the potential for nonpotable water use within the District's service area.

Water Reuse Zones. The WRMP designates Water Reuse Zones within the District's Service area where nonpotable water service has been determined to be reasonably available.

TYPES OF NONPOTABLE WATER USE

Use of nonpotable water may be required for nondomestic uses, which include but are not limited to: irrigation of cemeteries, golf courses, playing fields, parks and residential and nonresidential landscaped areas; commercial and industrial process uses; and toilet and urinal flushing in nonresidential buildings.

DETERMINATION OF FEASIBILITY OF NONPOTABLE WATER SERVICE

The District will identify customers within Water Reuse Zones and determine the feasibility of providing nonpotable water service to these customers. The District will also review applications for new services to determine the feasibility of providing nonpotable water service to these applicants. If nonpotable water service is determined by the District to be feasible, customers may be required to retrofit existing water service facilities to accommodate nonpotable water service and applicants for new water services may be required to install dual plumbing. Written notification of a determination of feasibility shall be provided to the customer or applicant during the water service application process as described in these regulations. Such notification shall include information regarding District water service procedures, a description of the water reclamation project, a description of any required retrofit facilities, and a description of any nonpotable water facilities that must be constructed, including dual plumbing.

NONPOTABLE WATER USE PERMITS

Upon approval of plans submitted to the District for necessary nonpotable and/or potable water distribution systems, the District will issue a nonpotable water use permit which, among other things, will specify the design and operational requirements for the customer's water distribution facilities. The District shall have the right to conduct a field inspection prior to permit approval and periodically throughout operation of the customers' nonpotable water system. Nonpotable water service will not commence until the District verifies compliance with the permit requirements. In special circumstances, as determined by the District, once the permit has been issued, a temporary potable water supply may be provided

SECTION 30

NONPOTABLE WATER SERVICE
(Continued)

until all requirements for nonpotable water delivery are complete. All potable water delivered will be billed at the prevailing potable water rate.

INSTALLATION AND MAINTENANCE COSTS

Except as otherwise provided herein, when an existing customer is required by the District to convert to nonpotable water service, the District will pay the reasonable capital costs of retrofitting the water service facilities on the customer's side of the water service meter and will also provide for the nonpotable water service facilities necessary to deliver nonpotable water to the meter. Applicants for water service and customers requesting installation of additional facilities in order expand capacity, or those customers requesting conversion to nonpotable service not required by the District, shall be responsible for the full capital cost of facilities necessary to deliver nonpotable water to the premises.

Once nonpotable water service delivery commences, the customer shall be responsible for all costs of operating and maintaining the water service facilities on the customers' side of the water service meter(s). In the event a customer's water volume demand is increased significantly as a direct result of water quality considerations due solely to the conversion to nonpotable water service, the District may apply a volume conversion factor to the customer's account such that the conversion will not result in an increase to the customer's overall cost of water service. The volume conversion factor shall be applied prior to establishing nonpotable water service, upon request by, and after receipt of adequate documentation of the projected demand increase from, the customer.

EBMUD REPORTS
EAST BAY WATER ISSUES

February 1993

EBMUD Proposes New Water Supply Program

Developing The Program

The East Bay Municipal Utility District is in the process of developing a Water Supply Management Program that will serve as a planning document to enhance the environment and provide a reliable, high-quality water supply through the year 2020.

EBMUD's goals are to meet the growing water needs of its own service area, improve Mokelumne River fishery resources, limit shortages during droughts and meet obligations for others who depend on the Mokelumne River.

The Draft Environmental Impact Statement/Report just released by the District is a program-level document designed to address federal and state environmental laws.

It examines the need for additional water, describes the planning process used to screen alternatives and examines the environmental consequences of those alternatives.

Subsequent project-specific

(See Program, Page 2)

In planning for a Water Supply Management Program to guide the District though the year 2020, EBMUD's Board of Directors has designated two of the six primary composite programs -- Programs II and IV -- as preferred alternatives, and the Board now seeks public comments.

The primary element of each is the use of groundwater storage. In normal and wet years, available water would be stored in the lower Mokelumne River's vast underground basin, and withdrawn in dry years for agricultural, fishery or urban needs, instead of taking water from the river.

Both Programs II and IV are considered to be environmentally superior alternatives for meeting the District's needs.

Composite Program II

Aqueduct Security

A 10-mile section of the Mokelumne Aqueducts through the Sacramento-San Joaquin Delta would be strengthened to protect against earthquakes.

Lower Mokelumne River Management Plan

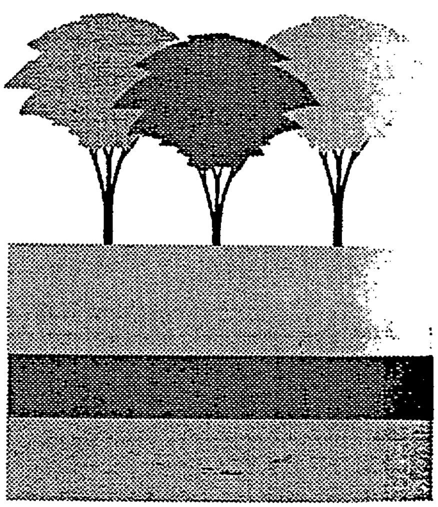
The plan would specify flows, reservoir operations, hatchery operations and spawning habitat enhancements to improve fisheries in the Mokelumne River.

Conservation/ Reclamation

These components would reduce the District's projected 2020 needs by 21 million gallons a day.

Groundwater Storage

Available surface water would be stored in an underground basin in normal and wet years and drawn from storage for agricultural irrigation, to augment flows in the lower Mokelumne River or pumped into the aqueducts for use by EBMUD's customers in dry years. The best site for groundwater storage is in San Joaquin County, near Lodi.



(See Water Supply, Page 2)

Water Supply

Continued from front page

However, several complex issues will need to be resolved.

Nevertheless, Composite Program II is the second least expensive of the six alternatives, with an estimated gross 30-year capital cost of $165 million.

Composite Program IV

This program includes the same components as Composite Program II, plus a supplemental water supply from the American River. Rights to use this supply are regulated by court order to comply with specific conditions. When allowed, American River water could be delivered to the Mokelumne Aqueducts by building a 16-mile pipeline to tap into the existing Folsom South Canal.

Addition of an American River supply to the program could increase the potential benefit to San Joaquin County and offers a regional approach to address water needs. Estimated 30-year cost is $262 million.

Program

Continued from front page

studies will be necessary for components that may result in significant environmental impacts.

EBMUD considered a wide range of potential elements to help meet its future water needs.

Five categories were identified and assessed:

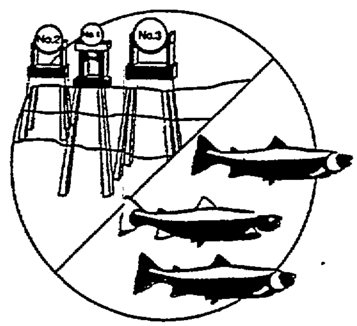
- Conservation
- Reclamation (recycled water)
- Groundwater storage
- Reservoir storage
- Supplemental supply

Alternatives considered best in each of those categories were identified and ranked by environmental impacts, costs and operational considerations, including technical feasibility and public acceptance.

These components became the building blocks of composite programs -- combinations of individual projects that collectively meet the District's needs. The environmental documents focus on the six Primary Composite Programs shown at right. These six composite programs, selected to present a range of alternatives, were given equal consideration in the environmental evaluation process.

In addition to the five categories of elements defined above, two other elements common to all six of the Primary Composite Programs were developed.

One, the Lower Mokelumne River Management Plan, focuses on fish habitat improvement. The second would strengthen a 10-mile section of the Mokelumne Aqueducts, EBMUD's three water supply lines across the Delta, to better protect them from earthquakes.



Estimated Rate Increase for Programs

Composite Program	Year 2000	Year 2010	Year 2020
I	24%	29%	26%
II	11%	9%	7%
III	30%	19%	16%
IV	16%	13%	10%
V	17%	11%	6%
VI	4%	4%	3%

PRIMARY COMPOSITE PROGRAMS

COMPOSITE PROGRAM THEMES	CONSER-VATION	RECLAM-ATION	STORAGE: GROUND-WATER — AGRICULTURAL, RIVER & AQUEDUCT	STORAGE: RESERVOIRS — RAISE PARDEE +150 AF	SUPPLEMENTAL SUPPLY: DELTA	SUPPLEMENTAL SUPPLY: AMERICAN RIVER
I Demand-Side Management	●	●				
II Groundwater Mokelumne	●	●	●			
III Delta Supply	●	●			●	
IV Groundwater With American River-Folsom South Connection	●	●	●			●
V Raise Pardee	●	●		●		
VI Groundwater Only			●			

Planning Criteria

Many complex factors are incorporated in EBMUD's water supply plan.

Some factors, such as operational criteria, can be controlled by EBMUD. The District may influence other conditions, such as fisheries releases and water use within the EBMUD service area. But others, including rain, snow and decisions by other agencies, are outside of the District's controls.

Hypothetical Drought

The drought experienced during 1976 and 1977 is the worst short-term water shortage on record, and would have been even more severe if 1978 had not been an unusually wet year. For planning purposes, EBMUD has used 1976 and 1977 plus another dry year for its own "worst-case"drought scenario.

A three-year drought of this severity would exhaust all accessible water supplies.

In five of the six Composite Programs, a 25 percent rationing program is assumed for drought years. In Composite Program I, which reduces demand without providing additional water supplies, rationing levels would be at 35 percent in drought years.

Customer Water Use And Service Limits

Normal-year customer water use is projected to increase from 220 million gallons per day in the 1990s to 250 million gallons a day by 2020. (This number would be reduced by conservation and reclamation projects included in five of six programs.) This projected increase is based on growth within the District's Ultimate Service Boundary.

Worst-Case Drought Scenario

Year 1 • 1976 actual precipitation and runoff

Year 2 • 1977 actual precipitation and runoff

Year 3 • an average of 1976 and 1977 precipitation and runoff

Other Mokelumne River Demands

Other factors affecting the need for additional water include diversions by water users in Amador, Calaveras and San Joaquin counties who have senior rights to water from the Mokelumne River, and increased allocations to Mokelumne River fishery resources.

Uncertainties

One of the greatest sources of uncertainty for EBMUD is the amount of water that will be required to be released to support fisheries. State Water Resources Control Board hearings which began in November will address changes to the existing Mokelumne River fishery requirements.

EBMUD has proposed a Lower Mokelumne River Management Plan, which would protect aquatic resources by increasing flows, improving the river habitat and hatchery and modifying reservoir operations. This plan, submitted to the State Water Resources Control Board, is key to the Water Supply Management Program.

EBMUD REPORTS
EAST BAY WATER ISSUES

August 1992

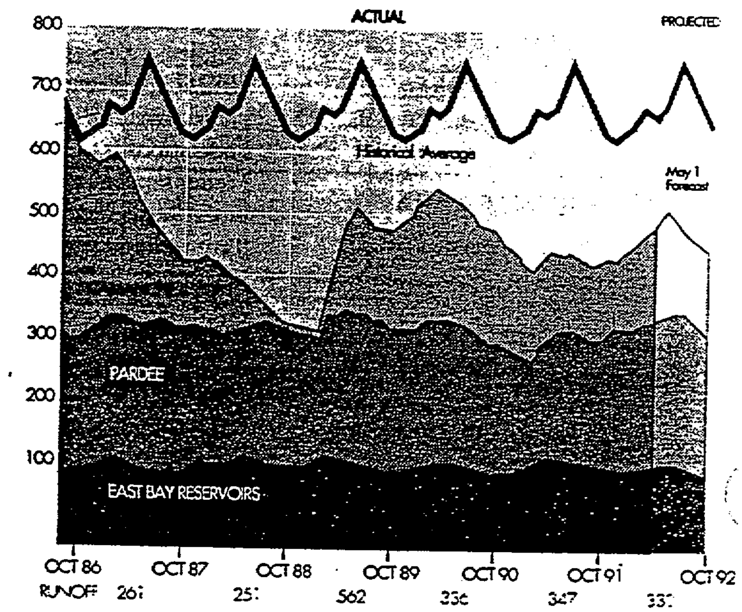
WATER PLANS

East Bay Municipal Utility District has been supplying high quality water to its customers for over 60 years. In recent years, customers have endured freeze, earthquake, firestorm and a continuing drought. Customers may wonder whether to replant trees or to invest in home or business improvements. Will there be enough water to go around? To answer that question, EBMUD has been engaged in a long-range planning program to assure a reliable water supply for the next 30 years.

These studies confirm that EBMUD's projected water needs, coupled with Mokelumne River fishery and other demands, indicate a serious potential water deficiency. Several alternative strategies are under consideration to meet the potential deficiency.

[illegible]pcoming Draft Environmental Impact Statement/Report [illegible]valuate alternative programs for EBMUD's future water supply management. The document will be available for public discussion and review in November, 1992.

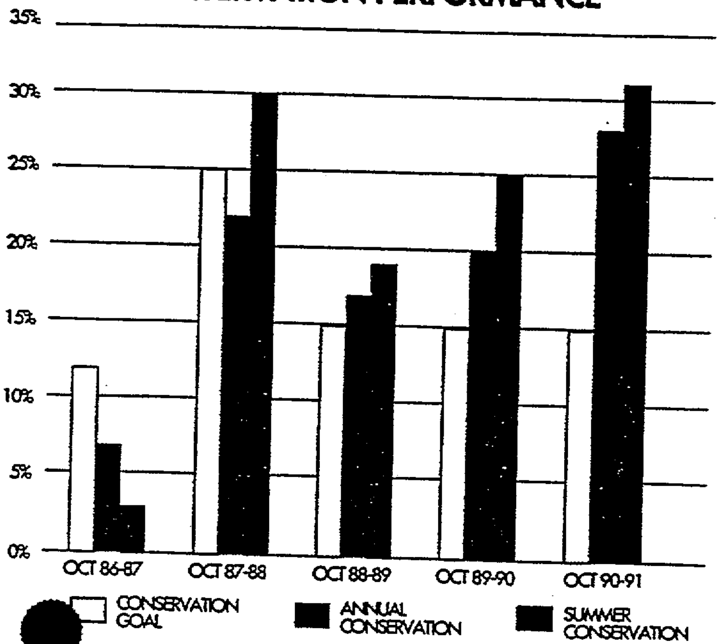
EBMUD TOTAL STORAGE AND RUNOFF



TAF=THOUSAND ACRE FEET AVERAGE RUNOFF = 735 TAF

The 1992 water picture for EBMUD customers includes a sixth year of drought and a **mandatory 15%** water conservation program

EBMUD CONSERVATION PERFORMANCE



The Draft EIS/EIR will present the District's long-term Water Supply Management Program (WSMP) and will:

- Identify and define conservation and reclamation measures – e.g., installation of ultra-low-flush toilets and use of reclaimed wastewater – to achieve permanent demand reduction which will help stretch drinking water supplies.
- Assure, in the event of recurring drought, that rationing will be limited.
- Invest judiciously in water supply projects – such as groundwater storage, increased reservoir storage, or other elements – to assure long-term reliability.
- Develop a long-term management plan to protect and improve the Mokelumne River fisheries.

WATER FOR THE FUTURE

MUD's *future water need* is defined ..e amount of additional water required in 2020 to limit drought restrictions to 25 percent of normal water demand levels when worst-case drought occurs. Future need also involves EBMUD's Mokelumne River water obligations, including significant increases for fish flow releases, other users' demands, and EBMUD's service area demand in 2020. With a worst-case three year hypothetical drought, planners project that extreme shortage conditions in 2020 will result in an EBMUD need for a minimum of an *additional* 130,000 acre feet of water. This need for additional water is the basis for designing the WSMP composite programs.

CUSTOMER DEMAND

In non-drought conditions, EBMUD's 1.2 million customers use approximately 220 million gallons of water per day. The 2020 water use in EBMUD's service area is projected to be about 250 million gallons -day. This figure assumes implementa- f EBMUD's current and planned ervation and reclamation projects as well as water-saving activities outside of EBMUD's programs (such as state-mandated efforts).

Per capita consumption will be relatively stable, at approximately 110 gallons per person per day. However, EBMUD's service area population in 2020 is estimated to be more than 1.3 million people, or an 12 percent increase over current population.

DROUGHT MANAGEMENT

EBMUD holds Mokelumne River water rights and contracts for a maximum of 325 million gallons per day, or 364,000 acre feet annually, though that amount is not currently available.

Average annual runoff in the Mokelumne Basin, the source of 95 percent of EBMUD's supply, is 735,000 acre feet; however, runoff during five of the six past drought years has been *less than half of* ...e. For example, 1992 Mokelumne ...unoff is projected at 300,000 acre ... The Mokelumne River runoff data, based on 70-year historical records, include several wet, normal and dry periods. Projections of future available water are based on this hydrological record, tested in an EBMUD computer model to simulate and compare future water supply with varying runoff conditions, including a worst-case drought.

EBMUD has simulated a worst-case drought sequence of three-year duration which is based in part on the worst drought on record, the 1976-77 experience, coupled with a third dry year. With early warning of low runoff and storage, the worst-case scenario will alert EBMUD to implement short-term customer rationing. EBMUD's overall water management objective for its reservoir storage and operations is to maximize the available water supply for its customers, while meeting all legal, environmental and institutional requirements and obligations.

OTHER DEMANDS

The District's water source is the Mokelumne River, but several agencies hold first or "senior" water rights, which must be met before EBMUD's needs. Five upstream water agencies and four groups of mostly agricultural downstream users – all holding Mokelumne River senior water rights – are expected to increase their demands through 2020. Demands may increase by nearly 30,000 acre feet in wet and normal years. Dry year demands, though less, also will have significant impacts on EBMUD's ability to meet its future need for water.

FISHERY NEEDS

The District is planning for additional water releases, likely to be required by the state and federal government, for fishery needs. Preliminary estimates of fishery requirements involve the evaluation of water temperature, water flow and non-flow related improvements. EBMUD's draft Lower Mokelumne River Management Plan proposes to release between 19,000 and 114,000 acre feet of water per year depending on dry, normal and wet year conditions and resulting reservoir storage levels. This fishery management plan is an essential foundation for analyzing the alternatives in meeting EBMUD's need for water in 2020.

The California Department of Fish and Game, the State Water Resources Control Board, and the Federal Energy Regulatory Commission are also evaluating additional Mokelumne River water releases for fishery needs. The State is also developing standards for water releases to enhance the public trust interests and protect the San Francisco Bay and Delta. District releases to meet any new Bay-Delta standards are assumed to be included in releases for Mokelumne fishery requirements.

Uncertainty regarding water requirements for fisheries is the single greatest source of variability in the EBMUD projections of water shortage and availability.

CONDITIONS THAT AFFECT EBMUD'S NEED FOR WATER IN 2020

- **Future Drought Conditions and Mokelumne River Runoff**
- **EBMUD's Customer Demand for Water**
- **Demands of Other Water Agencies**
- **Mokelumne River Releases for Fisheries and Bay/Delta Standards**

PRIMARY COMPOSITE PROGRAMS

COMPOSITE PROGRAM THEMES	CONSERVATION		RECLAMATION			STORAGE		SUPPLEMENTAL SUPPLY	
						GROUND-WATER	RESERVOIRS		
	INCENTIVE	MANDATORY	NON-RESIDENT. IRRIGATION	NON-RES. & FRONT YARD IRRIGATION	INDUSTRIAL USE	AGRICULTURAL, RIVER & AQUEDUCT	RAISE PARDEE +150 AF	DELTA	AMERICAN RIVER
Demand-Side Management Only (Conservation)		●		●	●				
Groundwater Storage Mokelumne Based	●		●			●			
Delta Supply	●		●					●	
Groundwater Storage American River Based	●		●			●			●
Foothill Storage	●		●				●		
Groundwater Storage Only						●			

[illegible] which were selected for detailed analysis by the EBMUD Board of Directors in April 1992, represent a range of alternatives [illegible] District.

WSMP STUDIES AND ISSUES

The Water Supply Management Program, with a Draft EIS/EIR expected in November 1992, is EBMUD's $15- million effort to develop a long-range plan that assures adequate water supply through the year 2020.

Over the past three years, as part of the WSMP, EBMUD has reviewed many alternatives for meeting future water supply needs. This effort has included reducing demand through conservation and recycled water use, and augmenting supply by storing more water – either in surface reservoirs or in underground basins – and by taking additional water from new sources.

From these alternatives the EBMUD Board of Directors has designated six composite programs for full-scale review in the upcoming Draft EIS/EIR. A composite program is a combination of elements that together is intended to meet future water supply needs. The six composite programs shown above consist of combinations of the following elements:

CONSERVATION - Measures may include increasing levels of residential inside and outside plumbing changes(ultra-low-flush toilets and drip irrigation equipment) and enhanced commercial and industrial water audits. Water savings are estimated to be from 7 million to 20 million gallons per day.

RECLAMATION - Recycled water projects could include supplying treated wastewater for major irrigators, dual-use systems at residential developments, and certain industrial processes, with potential savings from 8 million to 38 million gallons per day.

RESERVOIR STORAGE - EBMUD's Pardee Dam could be raised to create a much larger reservoir on the Mokelumne River. Of over 80 alternative sites studied, Pardee is the remaining surface storage concept in the composite programs.

GROUNDWATER STORAGE/ CONJUNCTIVE USE - In normal and wet years, excess water could be stored in the lower Mokelumne's vast underground basin, and withdrawn in dry years for agricultural, fishery or urban needs, in lieu of taking water from the river. This constitutes "conjunctive use."

SUPPLEMENTAL SUPPLY - The District has a U.S. Bureau of Reclamation contract for significant American River water, if downstream flow conditions can be met. The construction of a pipeline plus additional storage capacity would also be required with this option. Alternatively, water could be taken directly from the Delta, though a contract and extensive treatment would be needed.

KEY ISSUES

The Mokelumne Aqueduct improvements are on a fast track and, for planning purposes, are assumed to be accomplished in the WSMP. Recent engineering studies determined that the 11-mile elevated pipeline section of aqueduct in the Delta could be reinforced to withstand a maximum credible earthquake. This means that even if submerged in the event of levee failure, the aqueduct could continue to provide water from the Mokelumne River to EBMUD customers while levees are being repaired. With this issue addressed, the WSMP focus shifted to meeting drought year needs and possible storage facilities east of the Delta.

- The Los Vaqueros reservoir site, for which Contra Costa Water District has prepared a Project Draft EIS/EIR, is no longer under consideration by EBMUD due to the availability of alternatives with fewer environmental impacts, less cost, and higher water quality. Also CCWD's construction timing goals could not be met with a joint project.
- The requirements for Mokelumne River fisheries will play a critical role in EBMUD's determination of the water needed to meet all demands in the year 2020. The State is reviewing water rights on the Mokelumne River in November 1992. The results could further restrict EBMUD's available supply from this source.
- The Federal Energy Regulatory Commission recently announced intentions to review EBMUD's 50-year Pardee and Camanche hydroelectric licenses regarding concerns about the fisheries issues. Three Bay Area Congressmen, EBMUD, several cities, and the State Water Resources Control Board requested that FERC delay its review until the State water rights process is concluded.

HOW YOU CAN PARTICIPATE

- **READ:** EBMUD REPORTS on the WSMP are issued periodically. The Draft Environmental Impact Statement/ Report will be available by late fall 1992. To add your name to the mailing list, call 287-0145.
- **LISTEN:** To find out how the WSMP studies may affect you, schedule a speaker for your city, civic group, neighborhood council, public interest group, or homeowners association. Call 287-0145 to request a speaker.
- **WRITE:** What are your comments about the programs that have been selected? How might these programs affect you? Write to: EBMUD Public Affairs, P. O. Box 24055, Oakland, CA 94623
- **ATTEND:** Board meetings, public hearings, workshops, and community advisory committee sessions are open to the public. Board meetings are held on the second and fourth Tuesdays of the month at 1:15 p.m. in the EBMUD Administration Building, 375 11th Street, Oakland, CA. Call 287-0145 to receive notices and agendas.

EAST BAY
MUNICIPAL UTILITY DISTRICT
P.O. BOX 24055 • OAKLAND, CA 94623

Draft Environmental Impact Statement/Report

Updated Water Supply Management Program

WSMP

EXECUTIVE SUMMARY

1. EXECUTIVE SUMMARY

The East Bay Municipal Utility District (EBMUD, or the District) plans to adopt an Updated Water Supply Management Program (Updated WSMP) that includes new conservation and reclamation measures, a Lower Mokelumne River Management Plan (LMRMP), and a number of improvements to its water supply system. The improvements will allow the District to meet the growing demands of EBMUD customers, to meet the growing demands of other Mokelumne River water users, to improve the Mokelumne River fishery resources by implementing the LMRMP, and to meet shortages during droughts. The individual improvements are referred to as "components." When components are combined into a set of actions, the set of actions is referred to as a "Composite Program." Implementation of this Updated WSMP constitutes the "Proposed Action."

1.1 INTRODUCTION AND SUMMARY

This Environment Impact Statement/Environmental Impact Report (EIS/EIR) has been prepared as an update to the 1989 EBMUD Water Supply Management Program (WSMP). The 1989 EBMUD WSMP EIR was certified in March 1989 as a program-level document. Four different parties sued the District over alleged inadequacies in the 1989 WSMP EIR. The District decided to address the concerns raised by the litigants by preparing this EIS/EIR, a new and more comprehensive study. This EIS/EIR is also a program-level document, prepared to fulfill the requirements of both the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). A program-level document may be prepared under CEQA on "a series of actions that can be characterized as one large project, and are related as logical parts in a chain of contemplated actions" (CEQA Statutes and Guidelines, Section 15168). It is a public document that examines the need for the Updated WSMP, describes the planning process used to screen alternatives, and examines the environmental consequences of the Updated WSMP (or Proposed Action) and alternatives to the Proposed Action. Subsequent project-level studies and CEQA-documents will be prepared for those components of the Updated WSMP that may result in significant environmental impacts. The project-level studies will advance the level of detail about each component associated with the Proposed Action. Project-level studies will also provide the permitting agencies with the information necessary to make a determination of permit approval. The District is the lead agency for the EIR under CEQA. The U.S. Army Corps of Engineers (Corps) is the lead agency for this EIS under NEPA.

This EIS/EIR represents the documentation of a comprehensive effort to:

- determine how updated economic growth forecasts, water demand projections and cost estimates, as well as possible additional Mokelumne River flow requirements would affect the District's need for water and the feasibility of potential alternatives available to the District;

- address how possible droughts and increasing demands by other Mokelumne River water users would affect the District's need for water and the feasibility of alternatives available to the District;

- define and apply additional environmental and social planning objectives and criteria in the screening and selection of alternatives available to the District;

- determine how new developments, such as the availability of the American River supply, relate to and interact with the other alternatives available to the District for meeting its objectives; and

- address other program-level issues (e.g. growth-inducing impacts) raised during the 1989 WSMP litigation and during scoping for this EIS/EIR.

The first two items are documented in the need-for-water analysis. The District's need for additional water includes many supply, demand and operational conditions. The need for additional water for a worst-case drought scenario with rationing limited to an annualized system-wide 25 percent in the year 2020, including the implementation of an EBMUD-proposed LMRMP, is projected to be 130 thousand-acre-feet (TAF).

The screening process and the use of planning objectives and criteria included an extensive evaluation of alternative components and Composite Programs. Six Composite Programs were given equal consideration in the environmental evaluation process. At Updated WSMP Workshop #13 on September 15, 1992, the EBMUD Board of Directors agreed to pursue two alternatives that include groundwater storage/conjunctive use: Composite Program II or Composite Program IV. The Proposed Action is defined as the pursuit of either of these two Composite Programs, which include the following common components:

- *Aqueduct Security*. An approximate 10-mile section of the Mokelumne Aqueducts through the Sacramento-San Joaquin Delta would be secured against prolonged outages resulting from earthquake-induced failures.

- *LMRMP*. The Lower Mokelumne River Management Plan specifies flow regimes, reservoir operations, and hatchery operations that would enhance benefits to fishery resources in the Mokelumne River while maximizing flexibility in managing a variable water supply, uncertain future demands and uncertain linkages between fish populations and fishery management activities.

- *Conservation and Reclamation.* These two demand-side components would reduce the District's projected 2020 demand for water from 250 million gallons per day (MGD) to 229 MGD, a reduction of 21 MGD.

- *Groundwater Storage/Conjunctive Use.* Water would be stored in an underground basin when excess surface water supplies were available and could be withdrawn during drier years when surface supplies were below normal.

Groundwater storage/conjunctive use is considered to be the *environmentally superior alternative* for increasing storage and water availability, but its implementation would be institutionally very complex. The Proposed Action would include the possible adjunct of American River water delivered through the implementation of a Folsom South Canal Connection. In this approach, American River water available to the District under its 1970 contract with the U.S. Bureau of Reclamation would be conveyed to the Mokelumne Aqueducts through a 16-mile pipeline connecting with the current terminus of the existing Folsom South Canal.

1.2 THE NEED FOR WATER

The purpose of the Updated WSMP is to provide an adequate water supply. The future "need for water" is the additional water required at projected 2020 levels of development to limit drought restrictions to 25 percent of normal water demand levels when a worst case drought occurs.

1.2.1 Overview

Future water needs are defined by integrating and quantifying four problems and challenges as defined by the District Board of Directors:

- the number of District customers is projected to increase; therefore, the District's demand for water is expected to increase unless some action is taken;

- the demand for Mokelumne River water by non-District users is projected to increase;

- the District faces possible reductions in supply due to increased allocations of water to lower Mokelumne River resources, including fisheries. The number of salmon in the lower Mokelumne River has been reduced from previous conditions; and

- District customers face possible shortages of water from droughts.

The need for water is affected by many supply, demand, and operational conditions and is an important benchmark for long-term planning. Some of these conditions are within the District's control, such as operational criteria; some may be influenced by the District, such as water demand within the Service Area and additional releases for fisheries; and others are outside the District's control, including future precipitation and runoff and diversions by other agencies. The major factors affecting the need for water and the projected 2020 values for these assumptions are presented in **Exhibit 1-1**. The need for additional water at projected 2020 levels of development is 130 TAF during the three-year design drought and is the basis for designing the Updated WSMP Composite Programs.

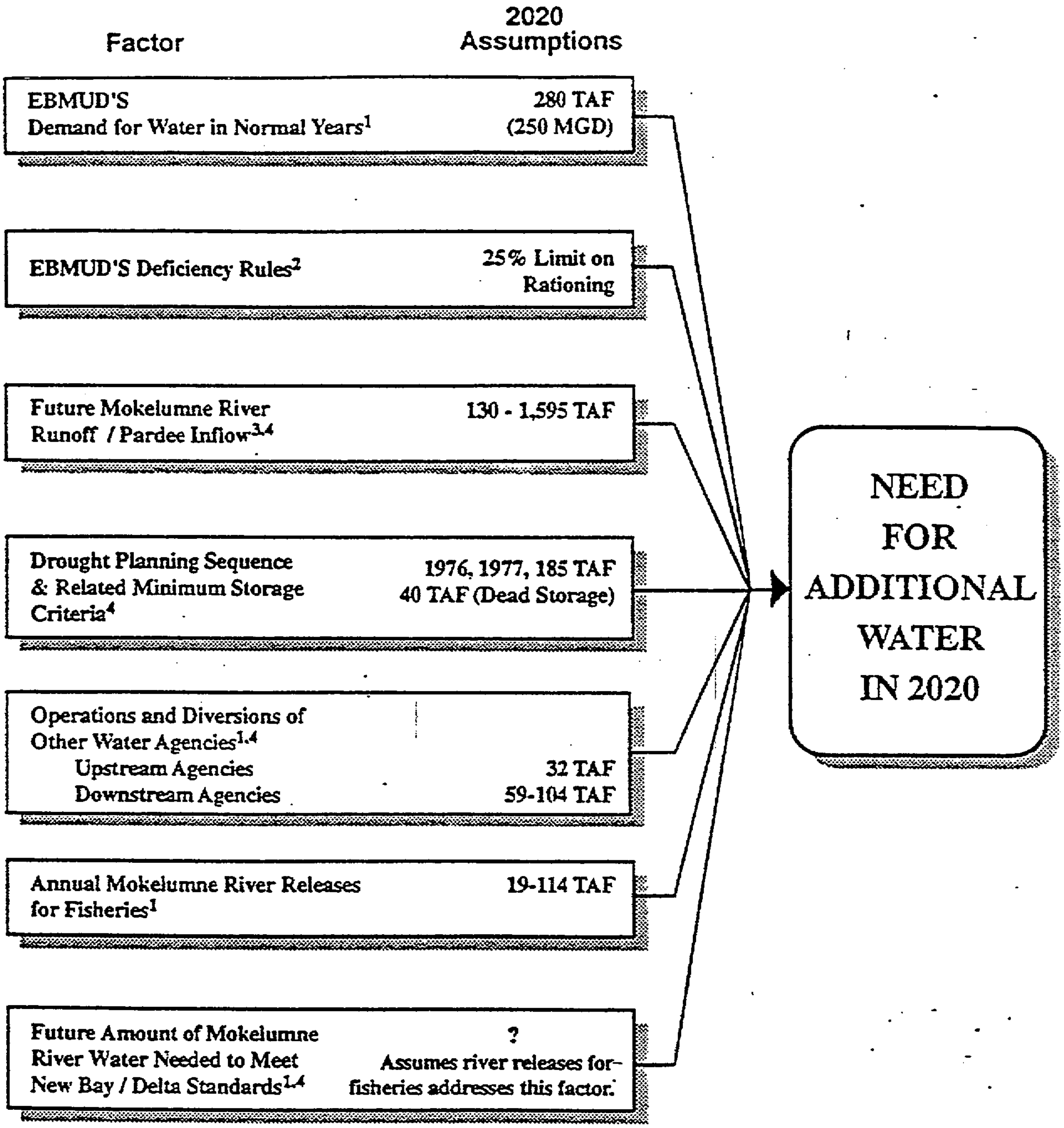
1.2.2 Customer Demands and Deficiency Rules

EBMUD customer demand is projected to increase from a 1990 level of 220 million gallons per day (MGD) (a normalized level of demand that assumes the current drought did not occur) to 250 MGD in 2020 (an average annual growth rate of 0.4 percent). This projection includes reductions for existing and adopted conservation and reclamation programs. EBMUD's storage capacity and rationing policy allows it to continue serving its customers during dry years. During dry periods, EBMUD imposes rationing on customers based on projected storage at the end of September. By applying deficiencies in the early years of a drought ("early deficiency rules"), EBMUD attempts to minimize rationing in subsequent years if a drought persists, while continuing to meet its current and subsequent year fish release requirements and obligations to downstream agencies. The limit of 25 percent reduction in average annualized system-wide water use was adopted as a reasonable planning criterion in 1989 to limit impacts on EBMUD customers.

1.2.3 Mokelumne River Runoff, the Drought Planning Sequence and Minimum Storage, and Demands of Other Agencies

The District uses 70 years of Mokelumne River streamflow data as the hydrologic database. This historic record is utilized by the District's computer-based Mokelumne River water balance model, EBMUDSIM. This model allows for the simultaneous consideration of many interrelated factors and is used as a water supply planning tool by estimating reservoir storage levels, downstream river flow rates, deliveries to customers, etc. over the 70-year study period based upon input assumptions for customer and other agency demands, fish releases, etc.

Exhibit 1-1
Major Factors and Assumptions Affecting the Need for Additional Water



Notes:
1 Conditions adding to the District's need for water
2 Conditions reducing the District's need for water
3 Conditions which could add to or reduce the District's need for water
Conditions largely outside District's control

TAF = thousand acre-feet
MGD = million gallons per day
LMRMP = Lower Mokelumne River Management Plan

Source: EDAW, Inc., and EBMUD

Precipitation and runoff are factors outside the District's control. The District's ability to store Mokelumne River water is the primary reason that, despite the high variability between normal- and dry-year runoff, water would likely be available to its customers in most years. In some years, however, runoff would not be sufficient to supply current needs. To simulate a worst-case drought event to define the District's need for additional water, a series of drought sequences were analyzed. While 1976-77 was the worst drought on record, it is possible that a similar event could occur some time in the future but without a very wet year like 1978 immediately following, making the drought more severe. To plan for the possibility of such an event during the 30-year planning period, an average of the two driest years on record, 1976 and 1977, has been used to replace the historical 1978 hydrology. The amount of runoff assumed to occur in the third year of the sequence is a critically dry flow of 185 TAF. In addition, it was assumed this 1976, 1977, 185 TAF "drought planning sequence" would not continue beyond the third year, and all accessible storage would be used without reserving water for a fourth dry year. The minimum storage level under this drought planning sequence would be 40 TAF, equal to the amount of the District's inaccessible, or "dead," storage.

Another factor affecting the need for additional water is the increasing level of demands of other agencies. The total demands of both upstream and downstream agencies with Mokelumne River water rights senior to the District's affect the District's need for water in two ways: by reducing the inflow to Pardee Reservoir and by increasing the District's release requirements from Camanche Reservoir.

1.2.4 Mokelumne River Fisheries and the Bay/Delta Proceedings

The fishery release requirements on the lower Mokelumne River are one of the greatest sources of variability and uncertainty in the projections of shortages and water availability. The objectives and flow requirements associated with EBMUD's proposed LMRMP will be addressed at the State Water Resources Control Board (SWRCB) hearings on the District's Mokelumne River water rights, currently in progress. Under the LMRMP, EBMUD is proposing to protect aquatic resources of the Mokelumne River by modified reservoir operations and increased releases of water, structural and operational improvements at the Mokelumne River Fish Hatchery, leadership and participation in non-flow enhancement measures, and continued monitoring and research. Recommended Mokelumne River minimum flows are based on temperature and habitat requirements balanced with water availability. Different flows are provided for different year types.

Up-Migration and Spawning

- Wet/Normal Years--flow would be released (from Camanche) to provide 100 percent of optimum spawning habitat.
- Dry Years--flow would be released to provide 80 percent of optimum spawning habitat.
- Critical Dry Years--flow would be released to provide 50 percent of optimum spawning habitat. Minimum passage flows would be provided below Woodbridge dam.

Fry and Juvenile Rearing

- Optimum flow (balanced with spawning flows and out-migration flows) would be provided in all years without flood control releases.

Out-Migration

- Wet/Normal Years--flow would be released to provide suitable temperature conditions for out-migrants through June. Out-migrants would be trucked past Lake Lodi and the Delta through July (1 percent of migrants).
- Dry Years--flow would be released to provide suitable temperature conditions for out-migrants through May. Out-migrants would be trucked past Lake Lodi and the Delta through July (30 percent of migrants).
- Critical Dry Years--flow would be released to provide suitable temperature conditions for out-migrants to Lake Lodi. All out-migrants would be trapped and trucked past Lake Lodi or returned to the hatchery for rearing.

One result of the SWRCB water rights or Bay/Delta hearings may be increases in the minimum required releases of water. The Composite Programs are based in part on the releases contained in the District's LMRMP and assume that these releases will satisfy required releases to the Delta that may be adopted by the SWRCB.

1.3 SELECTION OF SIX PRIMARY COMPOSITE PROGRAMS

In February 1990, EBMUD notified the public and resource agencies of its intent to prepare an Updated WSMP. Through the formal "scoping process," as defined by CEQA and NEPA, EBMUD solicited input on alternatives. The Updated WSMP addresses an extensive range of alternatives to help meet EBMUD's 2020 water needs. Alternatives include reducing demand on the Mokelumne supply through conservation and reclamation (the use of recycled water) and augmenting supplies through groundwater storage/conjunctive use, reservoir storage and supplemental supply.

1.3.1 Overview

A thorough alternatives screening process reduced the range of alternatives within each of the component categories based on evaluation using the District's planning objectives and related screening criteria. The District's planning objectives and screening criteria are very comprehensive and cover a broad array of issues. These are organized into the categories of: operational, engineering, legal and institutional; economic; public health, public safety and sociocultural; and biological. The surviving component alternatives were then used to develop alternative Composite Programs, or groups of demand-reduction and supply components that together would provide EBMUD with an adequate water supply. Six Composite Programs were identified to represent a reasonable range of alternatives. In addition to supply and demand alternatives, engineering solutions were developed to strengthen the Mokelumne Aqueducts to prevent a prolonged interruption of service as a result of a major earthquake. Strengthening of the Mokelumne Aqueducts is assumed as part of each Composite Program. Therefore, the Updated WSMP does not include extended outage of the Mokelumne Aqueducts as a water supply concern. **Exhibit 1-2** identifies the six Primary Composite Programs and indicates the components that form the Composite Programs. A description of each Primary Composite Program is provided in Chapter 7 of this EIS/EIR.

1.3.2 Conservation

EBMUD currently manages a wide-ranging and successful conservation program that includes education, incentives, regulation and ongoing studies. Conservation savings are achieved primarily by introducing water saving technology in the form of hardware and by persuading customers to use water more efficiently. Long-term hardware changes that could achieve additional water savings for EBMUD customers include the installation of ultra-low flush toilets, low flow showerheads and faucets, water-efficient appliances, efficient outdoor irrigation systems, and enhanced commercial and industrial water audits. Alternative programs studied include varying percentages of customer participation, inspections to assure that water-saving hardware will remain in use by customers, rebates, mandatory landscaping measures, and programs that foster public awareness of water use. Depending on the program chosen, water

Exhibit 1-2
Primary Composite Programs

PRIMARY COMPOSITE PROGRAMS	COMPONENTS	DMP	CONSERVATION (SAVINGS)[1]		RECLAMATION (SAVINGS)[1]			GROUNDWATER			RESERVOIR	SUPPLEMENTAL SUPPLY		Aqueduct Security	LMRMP	Composite Program Screening Designation[3]
		Maximum Deficiency[2]	II (18MGD)	IV (35MGD)	A1 (8MGD)	A2 (21MGD)	A6 (8MGD)	Agricultural Exchange	River Substitution	Direct to Aqueducts	Raise Pardee +150 TAF	Delta	Folsom South Connection			
I	Demand-Side Management	35%		●		●	●							●	●	X
II	Groundwater	25%	●		●			●	●	●				●	●	A'
III	Delta Supply	25%	●		●							●		●	●	B'
IV	Groundwater and Folsom South Connection	25%	●		●			●	●	●			●	●	●	C
V	Raise Pardee	25%	●		●						●			●	●	F
VI	Groundwater Only (Least Cost)	25%						●	●	●				●	●	J

Notes:

1 Savings indicated are in addition to savings from existing and adopted conservation and reclamation programs. Conservation and reclamation savings are not necessarily additive due to overlapping.

2 Drought Management Programs (DMP) are short-term rationing imposed on customers during droughts. A DMP would be implemented in addition to some level of conservation.

3 During the screening of alternative composite programs, the alternatives were identified by these letters.

Key

● Components included in Primary Composite Programs

Source: EDAW, Inc.

savings in the year 2020 are estimated to range from seven to 35 MGD above the savings already realized from existing and adopted conservation programs.

1.3.3 Reclamation

The use of recycled water for selected exterior irrigation and industrial process water is an ongoing EBMUD practice. A number of reclamation programs have already been implemented by EBMUD, and additional reclamation opportunities have been identified. The Updated WSMP alternatives analysis examined a full range of techniques including expanding the existing use of non-potable water by major irrigators (golf courses, parks), exporting treated wastewater to the Delta for salinity control, and pursuing advanced treatment technology for potable use of recycled water. The most feasible alternatives include additional reclamation projects that provide non-potable water for irrigation and industrial uses. In the year 2020, these projects could save the District between eight and 29 MGD above the savings already realized from existing and adopted reclamation programs.

1.3.4 Groundwater Storage/Conjunctive Use

The purpose of groundwater storage/conjunctive use is to store surface water in the ground in years when water is available and to use this stored groundwater in conjunction with or in lieu of surface water supplies in dry years. Potential basins with the ability to provide storage were examined and the best opportunities were found to exist in San Joaquin County near Lodi. A broad range of recharge methods and alternative withdrawal scenarios were evaluated. Successful implementation of both recharge and withdrawal mechanisms would rely on a high degree of cooperation between EBMUD and San Joaquin County entities.

1.3.5 Reservoir Storage

Alternative surface storage opportunities were examined at a number of locations throughout the Bay Area and Sierra foothills. The alternatives included the development of new reservoirs, the expansion of existing reservoirs, and cooperative efforts with other agencies for the development of reservoirs. Three reservoirs were found to be capable of meeting most of the identified need. These three alternatives, Buckhorn Reservoir, Los Vaqueros Reservoir and raising of Pardee Dam to expand Pardee Reservoir, were studied in more detail and one, Raise Pardee, was included in the Primary Composite Programs. The raising of EBMUD's existing Pardee Dam in the Sierra foothills presents an opportunity for increased storage with far fewer environmental impacts than would occur from development of the same amount of storage at a new site. The Los Vaqueros alternative, studied as a joint project with Contra Costa Water District (CCWD), is not being pursued because of its higher costs, potential health risks associated with drinking Delta water, environmental impacts, and incompatibility of CCWD and EBMUD implementation schedules.

1.3.6 Supplemental Supply

A number of sources of additional water for use by EBMUD customers were evaluated. Alternative sources ranged from diversions from the Delta to implementation of EBMUD's long-held but unused contract for water from the American River. Delivery systems for an additional supply ranged from pipelines to barges. Two alternatives were studied in more detail: diversions from the Delta and construction of a pipeline to allow EBMUD to utilize its existing American River contract with the Bureau of Reclamation.

1.3.7 Composite Programs

A range of Composite Programs was developed that would meet EBMUD's identified need for additional water in the year 2020. All but one Composite Program alternative rely on an assumption that an annualized maximum, system-wide, 25 percent reduction in demand accomplished through rationing could be achieved in times of drought. This maximum 25 percent reduction (called a Drought Management Program, or DMP) is consistent with existing District policy and allows EBMUD to impose reasonable limits on demand to preserve supplies for future dry years. With existing conditions, the 25 percent rationing alone is not sufficient to allow the District to meet its projected demand at 2020 levels of development. Measures to help the District meet demand include both demand reduction measures and additional storage and supplemental supply alternatives. One alternative Composite Program (the Demand-Side Management Composite Program) provides no additional supplies but includes aggressive conservation, reclamation, and drought management programs. The DMP would be increased from 25 percent to 35 percent to accommodate the resulting shortage. Another Composite Program developed as the Least Cost Alternative includes supply-side measures only (the Groundwater Only Composite Program). Others combine demand-reduction alternatives (conservation and reclamation) and additional supply sources (i.e., groundwater storage/conjunctive use, reservoirs and supplemental supply). These six Primary Composite Programs, summarized in **Exhibit 1-2**, are the focus of this EIS/EIR.

1.4 KEY IMPACT DISTINCTIONS BETWEEN COMPOSITE PROGRAMS

A comprehensive evaluation of all components and Composite Programs against the screening criteria was conducted. This section summarizes the most important distinctions between the six Primary Composite Programs. Two types of distinctions are considered: program-level and site-related.

This EIS/EIR is a program-level document prepared in accordance with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). Under CEQA, a program-level EIR may be prepared on a series of interrelated actions that can be characterized as one large action. The level of analysis in this document reflects the programmatic nature of the Updated WSMP including the impacts of each Primary Composite Program as a whole. Analysis of potential site-specific impacts is preliminary and limited in detail, because the sites, routes, designs, sizes and configurations of the individual projects that could be developed to implement the Updated WSMP (Proposed Action) are yet to be detailed. Additional environmental analyses of the project-specific impacts of the individual projects that comprise the Updated WSMP will be performed in more detail when individual projects are proposed.

This Executive Summary first presents key program-level considerations that distinguish the Primary Composite Programs, including issues that would affect internal EBMUD policies (such as operations and economics) or regional or state-wide issues such as growth-inducing impacts. *Program-level issues* have been identified to allow for the consideration of broad policy alternatives, and to ensure the consideration of cumulative impacts that might be overlooked on a case-by-case basis. These program-level considerations are summarized in Section 1.4.1. Key *site-specific impacts* that distinguish each Composite Program include public health, safety and sociocultural impacts and biological impacts associated with a particular project location or feature. These are summarized in Section 1.4.2.

1.4.1 Key Program-Level Distinctions

Each Composite Program has been developed to meet the District's need for additional water. The screening criteria have allowed the alternatives to be evaluated against a broad range of issues, resulting in the identification of alternative Composite Programs that represent a reasonable range of alternatives, generally with the fewest environmental impacts. At the program level of analysis, however, several issues distinguished the Primary Composite

Programs from each other. The major program-level distinctions are generally non-mitigable at the project level. They are highlighted in the following discussion to facilitate identification of issues raised during the 1989 WSMP litigation and during scoping for this document. These program-level issues are *not*, however, any more significant than site-related impacts and could, in fact, be site-related. They are identified in this section to distinguish them as impacts of selecting a particular Composite Program as the Proposed Action and to illustrate what that policy decision means to the District, to other agencies, or to the resources or issues of state-wide or regional importance. The major program-level distinctions are summarized in **Exhibit 1-3** and discussed below.

1.4.1.1 Institutional Reliability. Two Composite Programs appear to be distinctly less reliable than the others. Composite Program I would rely on mandatory demand-reduction measures and 35 percent rationing to meet the 130 TAF need for additional water during the three-year drought planning sequence, and Composite Program III would rely on the Delta to supplement the Mokelumne River supply. On the other hand, Composite Program V (Raise Pardee), once it were implemented, would likely be the most reliable.

Composite Program I - Demand-Side Management. There are many uncertainties about customer behavior. Estimates of expected participation and savings from Conservation Level IV may be too optimistic. Neither the extent of customer participation nor the long-term acceptance of many mandatory measures has been tested. No other water districts are known to have implemented such aggressive conservation programs at so large a scale.

Calculation methods and other assumptions rely on available data, many of which have only recently been developed and which have limited proven results. In order to sustain the high savings levels, especially in drought periods, significant monitoring, control of demand and follow-up enforcement procedures would be needed. Residential per capita use during a worst-case drought would need to be lower than that achieved during the 1976-77 drought.

Composite Program III - Delta Supply. This Composite Program would depend on the ability to withdraw water from the Sacramento-San Joaquin Delta when needed over the next 30 years. The central purpose of current Bay/Delta proceedings, begun in 1987, is to develop and implement water quality objectives to protect both the beneficial uses in the Bay/Delta and out-of-estuary beneficial uses of Bay/Delta waters. The planning and regulation process concerning

Exhibit 1-3
Key Program-Level Distinctions (Page 1 of 5)

	I - Demand-Side Management	II - Groundwater	III - Delta Supply	IV - Groundwater and Folsom South Canal Connection	V - Raise Pardee	VI - Groundwater Only
Operational, Engineering, Legal & Institutional (Page 1) Institutional Reliability	High levels of savings, particularly during droughts may not be achievable; would rely on continued customer cooperation and participation.		Unknown future restrictions on timing and rate of use of Delta water may make its use unreliable, especially in a drought.		Water stored in Pardee Reservoir would be available and controlled by EBMUD, making it very reliable institutionally.	
Technical Reliability			Complex water treatment and pre-treatment facilities could potentially become inoperable in the event of Delta flooding and the resultant changes in Delta salinity; reliability becomes uncertain and unpredictable.		Water would be delivered to East Bay by gravity and would be very reliable.	
Operational Flexibility	No new source. Flexibility would rely totally on customers' responsiveness.	Groundwater would add a second source of dry-year water.	Would add a second source of dry-year water independent of Mokelumne River. The source, however, has not yet been identified.	Groundwater would add a second source of dry-year water independent of Mokelumne River. The American Riveer would add a third source of water, independent of the Mokelumne River; would add flexibility and redundancy in the event the Mokelumne River supply were to become unavailable.		Groundwater would add a second source of dry-year water.
Implementation Flexibility		Groundwater program could be phased or expanded through the addition of recharge basins, surface water distribution systems and extraction wells.		Groundwater program could be phased or expanded through the addition of recharge basins, surface water distribution systems and extraction wells.		Groundwater program could be phased or expanded through the addition of recharge basins, surface water distribution systems and extraction wells.

Exhibit 1-3
Key Program-Level Distinctions (Page 2 of 5)

	I - Demand-Side Management	II - Groundwater	III - Delta Supply	IV - Groundwater and Folsom South Canal Connection	V - Raise Pardee	VI - Groundwater Only
Operational, Engineering, Legal & Institutional (Page 2) Implementation Logistics		Potential for a lengthy delay to obtain necessary agreements. Out-of-basin water transfers, either direct-to-aqueduct or for river-substitution, may further jeopardize implementation. Water for groundwater recharge can be accommodated within existing EBMUD water rights by taking credits for water saved through conservation and reclamation efforts.	Potential for a lengthy delay to obtain necessary agreements.	Potential for a lengthy delay to obtain necessary agreements. Out-of-basin water transfers, either direct-to-aqueduct or for river-substitution, may further jeopardize implementation. The continued pursuit of FSC may help groundwater implementation because it is consistent with San Joaquin County's policy of seeking an additional supply. Water for groundwater recharge can be accommodated within existing EBMUD water rights by taking credits for water saved through conservation and reclamation efforts.	Potential for a lengthy delay to obtain necessary agreements.	Potential for a lengthy delay to obtain necessary agreements. Out-of-basin water transfers, either direct-to-aqueduct or for river-substitution, may further jeopardize implementation.
Rationing	13 years with customer deficiencies (out of 70 years); 6 years with > 15% deficiency; 1 year with > 25% deficiency.	14 years with customer deficiencies (out of 70 years); 7 years with > 15% deficiencies.	14 years with customer deficiencies (out of 70 years); 7 years with > 15% deficiencies.	12 years with customer deficiencies (out of 70 years); 5 years with > 15% deficiencies.	14 years with customer deficiencies (out of 70 years); 7 years with > 15% deficiencies.	16 years with customer deficiencies (out of 70 years); 6 years with > 15% deficiencies.

Exhibit 1-3
Key Program-Level Distinctions (Page 3 of 5)

	I - Demand-Side Management	II - Groundwater	III - Delta Supply	IV - Groundwater and Folsom South Canal Connection	V - Raise Pardee	VI - Groundwater Only
Economic Impacts 2020 District Rates to Customers (Capital 67% Rate funded, 1.6 Debt Coverage Ratio, 1992 dollars)	$21.10 per 1,000 cubic feet; 26% increase above No-Action.	$17.91 per 1,000 cubic feet; 7% increase above No-Action.	$19.51 per 1,000 cubic feet; 16% increase above No-Action.	$18.41 per 1,000 cubic feet; 10% increase above No-Action.	$17.84 per 1,000 cubic feet; 6% increase above No-Action.	$17.23 per 1,000 cubic feet; 3% increase above No-Action.
Other Direct Costs to District Customers, (net of rebates) (Present Value 1992 $)	$400 million	$130 million	$130 million	$130 million	$130 million	$0
Costs per Acre-foot (excluding direct costs to customers) (Present Value, 1992 $/ac-ft)	$4,600	$1,700	$4,100	$2,000	$2,200	$800

Exhibit 1-3
Key Program-Level Distinctions (Page 4 of 5)

	I - Demand-Side Management	II - Groundwater	III - Delta Supply	IV - Groundwater and Folsom South Canal Connection	V - Raise Pardee	VI - Groundwater Only
Public Health, Public Safety, and Socio-cultural (Page 1) Short-Term Impacts to People	Conservation savings would be achieved through mandatory compliance. Severe drought restrictions would be enforced through extensive monitoring of customer water use by District employees.	Conservation savings would be achieved through voluntary compliance. Moderate drought restrictions.	Conservation savings would be achieved through voluntary compliance. Moderate drought restrictions.	Conservation savings would be achieved through voluntary compliance. Moderate drought restrictions.	Conservation savings would be achieved through voluntary compliance. Moderate drought restrictions.	No new conservation beyond existing and adopted program. No change to drought restrictions.
Growth-Inducing Impacts - Service Area	Service Area growth projections used in the need-for-water analysis are consistent with ABAG and city and county projections. Service Area growth is projected to be slower than the 2-county area as a whole. Aggressive demand reduction and drought measures could influence growth of residences and businesses.	Service Area growth projections used in the need-for-water analysis are consistent with ABAG and city and county projections. Service Area growth is projected to be slower than the 2-county area as a whole.	Service Area growth projections used in the need-for-water analysis are consistent with ABAG and city and county projections. Service Area growth is projected to be slower than the 2-county area as a whole.	Service Area growth projections used in the need-for-water analysis are consistent with ABAG and city and county projections. Service Area growth is projected to be slower than the 2-county area as a whole.	Service Area growth projections used in the need-for-water analysis are consistent with ABAG and city and county projections. Service Area growth is projected to be slower than the 2-county area as a whole.	Service Area growth projections used in the need-for-water analysis are consistent with ABAG and city and county projections. Service Area growth is projected to be slower than the 2-county area as a whole.
Growth-Inducing Impacts - San Joaquin County		San Joaquin County's water needs in 2020 were used in the need-for-water analysis, and were provided by San Joaquin County water agencies. Needs are assumed to be consistent with growth expectations. Elevated water table in Lodi area would be consistent with San Joaquin County policy.		San Joaquin County's water needs in 2020 were used in the need-for-water analysis, and were provided by San Joaquin County water agencies. Needs are assumed to be consistent with growth expectations. Elevated water table in Lodi area would be consistent with San Joaquin County policy. EBMUD's implementation of FSC connection could be used by San Joaquin County to wheel their own American River water if granted water rights.		San Joaquin County's water needs in 2020 were used in the need-for-water analysis, and were provided by San Joaquin County water agencies. Needs are assumed to be consistent with growth expectations. Elevated water table in Lodi area would be consistent with San Joaquin County policy.

Exhibit 1-3
Key Program-Level Distinctions (Page 5 of 5)

	I - Demand-Side Management	II - Groundwater	III - Delta Supply	IV - Groundwater and Folsom South Canal Connection	V - Raise Pardee	VI - Groundwater Only
Public Health, Public Safety, and Socio-cultural (Page 2) Recreation Impacts					1.25 miles of whitewater loss would further reduce the availability of this resource in California.	
Water Quality Impacts	Would maintain all-Sierra source for potable supply.		Lowest source water quality of the six Composite Programs. "Prudence requires that public water suppliers should minimize treatment uncertainties by seeking water from the best available source and as removed from the potential for degradation as possible." (SWRCB, Report of Referee, EDF vs. EBMUD)		Would maintain all-Sierra source for potable supply.	
Biological Wetlands Impacts					Loss of "waters of the U.S." would further reduce the availability of this resource in California, including the loss of a portion of free-flowing river.	
Fisheries Impacts			The Delta withdrawal associated with this Composite Program would cause habitat loss, changes in flow regime and increases in diversions from the Delta, and would contribute to the decline of species of special concern.			

the Delta is complex, controversial and lengthy. It is likely to continue and could place future restrictions on the use of Delta waters by the District. Even if the "take-out" at Bixler, for instance, were initially approved and a facility constructed, there is no assurance that ongoing concerns for the Delta would not prohibit EBMUD from realizing this yield at some unknown future time. This is especially true since EBMUD would need the water during a severe drought, when other users would most need Delta water and when the resources of the Delta would be most stressed. There is, therefore, serious question whether a Delta Supply source would meet the District's need for water.

Composite Program V - Raise Pardee. Pardee Dam and Reservoir, along with substantial surrounding watershed lands, are owned and operated by EBMUD. Within the terms of its rights, licenses and permits, the District has a high degree of autonomy in project operations. This is distinct among the Composite Programs, and this Composite Program would likely be the most institutionally reliable assuming it could be implemented.

1.4.1.2 Technical Reliability. One Composite Program appears to be less technically reliable than the others: Composite Program III would require more complex pre-treatment processes and reverse osmosis, making it less reliable. Composite Program V would be the most technically reliable of the six Composite Programs because the added water would be delivered to the Service Area by gravity flow and would require the least treatment.

Composite Program III - Delta Supply. This Composite Program would require the most complex water treatment facilities of any Composite Program. While the technology is known and proven, as with all mechanical devices, the greater the complexity the greater the potential for technical failure. This level of complexity is unique to Composite Program III. In addition, the Delta is vulnerable to earthquakes. Earthquake-induced failure of the levees and the resultant flooding of the Delta could impact Delta water quality for months, making the water treatment plant's operations problematic. This level of earthquake sensitivity is unique to Composite Program III.

Composite Program V - Raise Pardee. Raise Pardee utilizes the existing EBMUD operations and treatment systems, utilizing gravity flow through the Mokelumne Aqueducts. This is distinct among components and would provide the District with a high degree of reliability. Composite Programs II, III, IV and VI all would require pumping, which would present some additional possibility for technical failure when compared to conveyance by gravity flow.

1.4.1.3 Operational Flexibility. Composite Program operational flexibility is measured by the system's ability to respond to change. Change could include additional water demands or reductions in the availability of supply. Composite Program IV would offer the most operational flexibility because of the redundancy of supply sources. Composite Program I, on the other hand, would remove the function of flexibility from the District's current approach to controlling supply and replace it with the customers' responsibility to control demand.

Composite Program IV - Groundwater and Folsom South Canal Connection. All Composite Programs utilizing groundwater would add a second source of dry-year water. As Mokelumne storage decreases, District operators could hold reservoir storage and introduce groundwater to the aqueducts through any of the extraction methods. The Folsom South Canal Connection would add a third source, thereby providing additional redundancy in the event the Mokelumne River supply were to become unavailable.

Composite Program I - Demand-Side Management. District operators currently can move water from foothill to local storage to respond to changing conditions such as runoff and demand. As storage decreases, rationing imposed on customers increases, consistent with current District policy. Because of the high levels of base conservation and reclamation in this Composite Program, customers may not be able to achieve the required drought year rationing. Flexibility would be removed from the operators' control and would be passed on to the customer.

1.4.1.4 Implementation Flexibility. Composite Programs with major construction projects or long lead times may not be as flexible to implement. These projects would include the raising of Pardee Dam, a Delta treatment plant, and the Folsom South Canal Connection. Conservation and Reclamation programs could be phased to achieve intermediate levels of savings. Groundwater elements in Composite Programs II, IV and VI could be phased or expanded through the addition of recharge basins, surface water distribution systems, and extraction wells.

1.4.1.5 Implementation Logistics. Given today's regulatory climate and increasing concerns over environmental issues, any new water supply program would be difficult to implement, and the evaluation of the Composite Programs against these criteria is somewhat subjective. Each of the Composite Programs would have unique obstacles related to implementability. There would be no certainty that any one of the Composite Programs would be any easier to implement than the other five Composite Programs. Professional judgement has, therefore, necessarily been applied in the evaluation process.

Composite Programs II and VI, which would rely on groundwater storage/conjunctive use, would have distinct uncertainties about their implementation. Composite Program IV, pairing a groundwater storage program with the Folsom South Canal Connection, is designed to help address this concern and is judged to be distinctly more implementable than Composite Programs II or VI. At the December, 1991 EBMUD Board of Directors WSMP Workshop #8, San Joaquin County's representative stated that one condition for EBMUD's participation in a groundwater storage/conjunctive use program in San Joaquin County would be to bring additional water into San Joaquin County in order to make a greater contribution to "filling" the vacant aquifer volume. They also stated that their basin "stabilization" goals could not be achieved without American River water.

Significant institutional constraints affecting the feasibility of a conjunctive use program must be overcome before such a program could be implemented. Constraints include the designation of a groundwater management entity in San Joaquin County, negotiation of agreements for joint programs with San Joaquin County, and other lower Mokelumne River water users. Potentially, the acquisition of water rights for groundwater recharge and withdrawal would be required. These constraints would introduce an element of uncertainty that could affect not only the timing but also the likelihood of ever implementing a conjunctive use program.

Resolution of institutional constraints could require many years. On the other hand, legislation or drought-induced necessity could help resolve these issues. The amount of time required to resolve these considerations would depend on EBMUD's commitment to the program, strong leadership, and the cooperation of and benefit to San Joaquin County and its residents.

1.4.1.6 Minimize Rationing. Composite Program I would be the only Composite Program with customer deficiencies greater than 25 percent. In the third year of the drought planning sequence, system-wide annualized rationing of 35 percent would be imposed. This rationing level would require an approximate 50 percent reduction in water use by residential customers.

1.4.1.7 Economic Impacts. A summary of key economic parameters is presented as **Exhibit 1-4.** Composite Program VI would be the least expensive, and Composite Program I would be the most expensive for all parameters considered.

Gross capital costs range from $122 million for Composite Program VI to $400 million for Composite Program I, with the present value of all capital repayment, operations, and maintenance costs totaling from $110 million for Composite Program VI to $650 million for Composite Program I. Unit costs would range from $800 per acre-foot for Composite

Program VI to $4,600 per acre-foot for Composite Program I. Composite Program VI would have no direct customer costs, while the $400 million present value of Composite Program I direct customer costs would increase the unit cost to $7,500 per acre-foot. Rates would increase by about four percent with Composite Program VI and by up to 30 percent for Composite Program I.

System Capacity Charges, fees charged to new water service applicants to pay a portion of the cost of providing new water service capacity, would decline from existing rates for Composite Programs II, IV, and VI, would remain about the same for Composite Program V, and would increase moderately for Composite Programs I and III.

Composite Program II would be the second least expensive for all parameters, with a gross capital cost of $165 million, a unit cost of $1,700 per acre-foot, and rate increases generally less than 10 percent. Direct customer costs for Composite Programs II, III, IV and V would have a present value of $130 million, which would add approximately $900 per acre-foot to the unit cost.

Composite Programs IV and V would the next least expensive. Composite Program V would have higher capital costs and Composite Program IV would have higher operations and maintenance costs. Both Composite Programs would have similar System Capacity Charge impacts, rate impacts, and unit costs ($2,000 and $2,200 per acre-foot, respectively).

Composite Program III would be the second most expensive for all parameters, with capital, operation and maintenance costs approaching those of Composite Program I, a unit cost of approximately $4,100 per acre-foot, and rate increases ranging up to 30 percent. Composite Program III would be the most affected by increases or decreases in the price of energy.

1.4.1.8 Short-Term Impacts to People. The Composite Programs fall into three distinct groups relative to this concern:

Composite Program I - Severe drought restrictions
Composite Programs II through V - Moderate drought restrictions
Composite Program VI - No change

Exhibit 1-4
Summary of Key Economic Parameters

		Composite Program					
		I	II	III	IV	V	VI
Gross Capital Cost		$400M	$165M	$378M	$262M	$322M	$122M
Present Value Cost (1992-2020 costs less 2020 net salvage)		$650M	$230M	$610M	$340M	$290M	$110M
Direct Customer Costs Present Value		$400M	$130M	$130M	$130M	$130M	$0
Unit Cost Present Value	Without Direct Customer Costs	$4600/AF	$1700/AF	$4100/AF	$2000/AF	$2200/AF	$800/AF
	With Direct Customer Costs	$7500/AF	$2600/AF	$5000/AF	$2900/AF	$3100/AF	$800/AF
Total System Capacity Charge (assuming 1/3 of capital costs are SCC funded)	Region 1 (no action = $1600)	$1900	$1000	$1700	$1300	$1500	$800
	Region 7 (no action = $8100)	$9200	$6700	$8800	$7700	$8200	$6300
Rate Increase Above No-Action (assuming 2/3 of capital costs are rate funded, 1.6 debt service coverage ratio)	2000	24%	11%	30%	16%	17%	4%
	2010	29%	9%	19%	13%	11%	4%
	2020	26%	7%	16%	10%	6%	3%

Composite Program I would introduce a demand-side management approach to managing the future water supply. The existing District deficiency policy of a maximum system-wide 25 percent customer reduction would be revised to allow up to a 35 percent system-wide reduction. Severe drought restrictions would be placed on customers, especially the residential category, which would experience up to a 50 percent rationing during the third year of the drought planning sequence.

Composite Program I - Demand-Side Management (Conservation Level IV, Reclamation Alternatives A2 and A6, 35 Percent DMP). The following discussion assumes that the expected savings would be achieved, despite the uncertainties of reliability discussed in Section 1.4.1.1 The socioeconomic effects of Composite Program I would occur primarily during a severe drought, especially in the third year when a 35 percent rationing program would be imposed. This 35 percent reduction would be a system-wide annualized average and would be higher for residential customers, especially in summer months.

During normal or wet years, the implementation of Conservation Level IV (without any DMPs in most of those years) and the development of Reclamation Alternatives A2 and A6 would be expected to have some negative socioeconomic impacts and some positive ones, assuming the savings would be as estimated. Negative impacts would include costs to households to re-landscape after a drought and the necessity to adapt to a different type of (water-conserving) landscape material. In addition, enforcement of Conservation Level IV would include extensive monitoring of customers' water use by District employees.

For non-residential customers, reductions required by the DMP would not be as high as those required for residential customers. This is because residential customer demand is 60 percent of the District's metered demand during normal years, and cuts would be made where the most potential for savings could be achieved. It is also because much of the non-residential water use is critical to the economic well-being of firms and to the area's economic health. Effects on businesses could in turn affect residential customers who are employees of these firms more severely than restrictions on their household water use. The appeals and exemption process would also likely be more successful with non-residential customers where jobs and economic well-being are involved. Firms that could claim severe hardship would include landscape contractors and nurseries, whose well-being is often directly tied to the residential customers discussed above.

Composite Programs II, III, IV, and V (Conservation Level II and Reclamation Alternative A1). Except for a moderate voluntary program of replacing toilets, most of the conservation efforts in Conservation Level II would be expansions of the District's existing and adopted programs. They would be expected to have only minor impacts on individuals, households and businesses. A 25 percent rationing would have drought-related negative effects; however, these should be less severe than those of the 35 percent rationing imposed in Composite Program I.

Composite Program VI. This Composite Program would employ only existing and adopted conservation and reclamation programs, and socioeconomic impacts from these components are not expected.

1.4.1.9 Growth-Inducing Impacts. Making the water supply more reliable and securing drought year water to support additional growth could have East Bay growth implications. This would hold true for all Composite Programs. In addition, indirectly securing San Joaquin County's dry-year yield by proceeding with groundwater could also affect San Joaquin County's growth. The completion of the Folsom South Canal Connection could further influence growth in the Sierra Foothills region by providing access to an American River supply.

All Composite Programs. The provision of water is both growth-inducing and growth-accommodating and depends more on individual perspective than on any objective analysis. Water is only one of many factors that influence growth. Households move into or stay in an area because of housing costs, job opportunities, public services (especially schools), taxes, perceptions of crime or public safety, transportation systems and costs, cultural and recreational amenities, lifestyle needs, and the proximity of friends and relatives. The location factors affecting development decisions by commercial and industrial firms include many of the concerns of residential decision makers.

These location decisions are filtered through the political process, especially through the planning, zoning and development activities of individual cities, counties and regional agencies. The estimates and projections of the District's future water demand are based primarily on the planning and growth policies of those jurisdictions within the District, as reflected in the Association of Bay Area Government's (ABAG) growth projections. ABAG in its *Projections 90* report states that "the key assumptions . . . are local governments' plans, policies, and regulations affecting the use of land. Local development policy reflects city, county and service district intentions to regulate development and to support it with urban services, such as sewers, water and roads . . . The projections process included extensive local participation and review."

ABAG has recently released 1992 projections. These data were not available, however, at the time the Updated WSMP demand projections were developed.

At this time, therefore, District projections are based on the growth policies and expectations of those jurisdictions within its currently defined Ultimate Service Boundary (USB). District projections do not exactly coincide with every jurisdiction's projections, but they are as close as can be expected given the assumptions and qualifications that normally accompany population projections. If the District were to change its USB or be forced by legal action or other means to expand service outside the present USB, then the projections would need to be adjusted accordingly. On the other hand, if the District is able to resist expansion, the result could be that growth outside the USB would be limited. While other jurisdictions actually enact and implement land use policies, whether or not the District supplies water in an area could effectively encourage or limit growth.

This growth discussion is applicable to all Composite Programs, although there could be some instances of households and businesses leaving or deciding not to move into the District's Service Area if they perceive the planning assumptions under Composite Program I to be too uncertain or too risky for their needs.

Composite Programs II, IV, and VI. If the groundwater table in San Joaquin County were left with a net increase after the dry year needs of EBMUD were met, and if any county were to attempt to utilize the additional water without reducing its use of an equal amount of water from a separate source, these Composite Programs could be assumed to be growth inducing and growth accommodating, just as would be the provision of water within the District Service Area. Composite Program IV, combining groundwater with the American River source, could be even more growth-inducing than groundwater alone. San Joaquin County has identified the American River as the additional water source necessary to achieve its goal and may wish to use the Folsom South Canal Connection for the conveyance of water that the county gains the right to purchase. Therefore, Composite Program IV could be potentially more growth-inducing in San Joaquin County than Composite Programs II or VI.

1.4.1.10 Recreation Impacts. Inundation of 1 1/4 miles of the existing Electra Run on the Mokelumne River would subtract from a state-wide resource that has already been reduced. This would occur at the same time that the population of California and the nation is growing and demands for wilderness outdoor experiences or eco-tourism are increasing. Accordingly, Composite Program V would be distinct in its program-level implications for recreation.

1.4.1.11 Water Quality Impacts. Composite Programs I and V would rely wholly on the high quality Mokelumne River as the ultimate source of water for District customers. Pursuit of any other Composite Program would indicate a change in District policy.

Composite Program IV would add American River water through the Folsom South Canal Connection. Composite Programs II, IV and VI might add a lower quality supply source, groundwater, to the District's drinking supply if the direct-to-aqueducts method were implemented. Composite Program III, Delta Supply, would be distinctly inferior, however, in terms of water quality.

Composite Program III - Delta Supply. Of the ten alternative water sources studied for the Updated WSMP, Delta water (whether used alone or in a Delta-Mokelumne blend) ranked lowest of the sources in before-treatment quality. Delta water contains high levels of several carcinogens (Trihalomethanes, or THMs) and other unhealthy constituents (bromate). THMs are known carcinogens, and bromates are suspected carcinogens. While it is currently believed high levels of treatment can reduce these contaminants to safe levels, there may be other unknown contaminants or undiscovered risks concerning known constituents. Therefore, there are health risks associated with Delta water regardless of the level of treatment.

The State Water Resources Control Board[1] (1988a) concluded in its report as referee in the case EDF et. al. v. EBMUD, "Prudence requires that public water suppliers should minimize treatment uncertainties by seeking water from the best available source and as removed from the potential for degradation as possible." Treatment of lower quality sources can be extremely costly and there is always the risk that treatment plants will fail to reliably remove contaminants from lower quality sources.

EBMUD *does* have choices in source water quality, and Composite Program III would be distinctly different in its use of Delta water. More serious a concern is what is not presently known about Delta water, what new contaminants or carcinogens will be discovered in the future, and whether EBMUD wants to build its future supply expectations around a water source of continued uncertainty with regards to quality.

[1] California State Water Resources Control Board. 1988a. Report of Referee, Lower American River Court Reference (EDF et. al. v. EBMUD).

1.4.1.12 Wetlands Impacts. While the actual acreage of affected wetlands may be small, cumulative impacts are an issue due to large regional and state-wide losses of riparian habitat in the recent decade. Because of historic cumulative losses, further loss or degradation of riparian habitat associated with Raise Pardee distinguishes Composite Program V.

Composite Program V - Raise Pardee. At the program level, it appears that Composite Program V's Raise Pardee component would have distinctly more wetlands impacts than the other Composite Programs. This conclusion could change at the project level as other components are sited and designed, but it is believed that all other components have more locational flexibility to avoid or minimize wetlands impacts. Specific impacts of Raise Pardee would include the inundation of over 31 acres of "other waters of the U.S.," which includes a portion of the river itself.

1.4.1.13 Fisheries Impacts. All of the Composite Programs include the LMRMP and are expected to improve the fisheries conditions in the lower Mokelumne River. Composite Program III, however, would rely on pumping water from the Sacramento-San Joaquin River Delta and would have distinctly different potential impacts to fish than other Composite Programs.

Composite Program III - Delta Supply. Changed Delta inflows could affect fisheries using the central Delta through many mechanisms: changed dispersion of eggs or young; changes in the proportion of water diverted and amount of reverse flow; changes in turbidity, changes in habitat and predation; changes in nutrient loads through a change in water temperature or positioning of the entrapment zone; or salt water-fresh water mixing. Potential impacts on Delta fishery resources could prohibit Composite Program III from being implemented now or could stop its operation later.

1.4.2 Key Site-Related Impact Distinctions

This EIS/EIR contains an analysis of site-related impacts of each Primary Composite Program and its components commensurate with the current level of facility design. At the program level of analysis, some impacts stand out and distinguish the Composite Programs from each other. They are summarized in **Exhibit 1-5** and are discussed below. While some impacts have both program-level implications and site-related impacts, discussions covered in Section 1.4.1, Program-Level Impacts, are not repeated.

1.4.2.1 Cultural Impacts. Because of the potential to carefully locate most components, impacts could likely be avoided or minimized in Composite Programs I, II, III, IV and VI. The raising of Pardee Dam, however, would inundate approximately 890 acres of land. Partial surveys indicate that four isolated artifacts and a minimum of 27 cultural sites would be inundated, including eight prehistoric resources, 13 historical resources, and six resources exhibiting both historic and prehistoric features. One of the archaeologic resources is the large prehistoric/ethnohistoric village site located at the Wildermuth House. Mitigation may involve using archaeological excavation techniques and possibly removal of Native American human remains.

1.4.2.2 Short-Term Impacts to People. Reclamation pipeline construction and water treatment plant expansion would have the highest potential to disrupt urban and suburban residences and businesses. Reclamation Alternatives A2 and A6 would have by far the most such construction. Reclamation Alternative A2 would have approximately 125 miles of construction in existing streets, and Reclamation Alternative A6, approximately 20 miles. It is likely that this construction in Composite Program I would be the most disruptive of any in the six Composite Programs. Also in Composite Program I, compliance with the mandatory measures and interior water audits of the conservation program, involving inspection of private residences by District employees, could affect all customer categories. Only Composite Program VI, with no additional conservation or reclamation components, would have no short-term impacts to people.

1.4.2.3 Long-Term Impacts to People. Composite Program I would mandate changes in indoor and outdoor water use and landscape practices in the Service Area. Composite Programs II, IV and VI would require changes in agricultural irrigation practices in San Joaquin County in order to accommodate differences in using groundwater and surface water for irrigation. Groundwater facilities, as configured for cost estimating purposes, would occupy up to 360 acres over the 160,000-acre lower Mokelumne River area. However, the facilities would not be large or unusual in nature for an agricultural area and could be accommodated with few negative impacts to people. For Composite Program III, the treatment plant site would permanently occupy approximately 70 acres of land in a rural area. Any physical facility has potential long-term impacts to people. The Folsom South Canal Connection of Composite Program IV would be an underground pipeline and could be routed almost entirely in existing rights-of-way, minimizing long-term impacts to people. Composite Program V would inundate approximately 890 acres.

Exhibit 1-5
Key Site-Specific Impact Distinctions (Page 1 of 2)

	I - Demand-Side Management	II - Groundwater	III - Delta Supply	IV - Groundwater and Folsom South Canal Connection	V - Raise Pardee	VI - Groundwater Only
Public Health, Public Safety and Socio-cultural Cultural Impacts	Because of the potential to carefully locate most components, impacts could likely be avoided or minimized.	Because of the potential to carefully locate most components, impacts could likely be avoided or minimized.	Because of the potential to carefully locate most components, impacts could likely be avoided or minimized.	Because of the potential to carefully locate most components, impacts could likely be avoided or minimized.	Records search/archival data and incomplete surveys indicate 26 sites may be flooded, including: 1 site with contemporary Native American concerns, and the Wildermuth House.	Because of the potential to carefully locate most components, impacts could likely be avoided or minimized.
Short-Term Impacts to People	Approximately 145 miles of reclamation pipeline construction in existing urban and suburban streets and wastewater treatment plant expansions would have the highest potential to disrupt residences and businesses. Compliance with mandatory measures and interior water audits of the conservation program could affect all customer categories because of frequent contact by District personnel.					No new reclamation or conservation components.
Long-Term Impacts to People	Major changes in outdoor water use and landscape practices in the service area.	Changes in agricultural practices in the groundwater basin area of San Joaquin County. Up to 360 acres of groundwater facilities.	70 acres would be removed from use for the water treatment plant.	Changes in agricultural practices in the groundwater basin area of San Joaquin County. Up to 360 acres of groundwater facilities.	Underground pipeline along existing rights-of-way.	Changes in agricultural practices in the groundwater basin area of San Joaquin County. Up to 360 acres of groundwater facilities.

channels. The larvae are washed to the mixing zone where conditions are more favorable for growth. Important factors in the species' decline include habitat loss, change in flow regime, and increases in diversions.

The Sacramento splittail (*Pogonichthys macrolepidotus*), another species of special concern, is native to the Central Valley but is now found in the Delta, Suisun Bay and Marsh, and other parts of the estuary. Factors cited in the species' decline primarily involve loss of spawning and upstream habitat.

In addition, anadromous fish often have specialized water quality requirements for reproduction, e.g., reproductive success can be affected through changes in environmental stimuli for migration and spawning involving attractants, salinity, and water temperatures. Important anadromous fish using the Delta for part of their life cycle include chinook salmon (*Onchorhynchus tshawytscha*), steelhead trout (*Oncorhynchus mykiss*), striped bass (*Monroe saxatilis*), green and white sturgeon (*Acipenser sp.*), and American shad (*Alosa sapidissima*).

Composite Program III would also include a 22-mile pipeline to Suisun Bay for disposal of the brine waste-product from desalination. The site was selected to be far enough west past the Delta to minimize negative water quality impacts of increased salinity.

1.4.3 Conclusions by Primary Composite Program

1.4.3.1 Composite Program I (Demand-Site Management). It is uncertain whether Composite Program I could achieve the required savings. It would have short-term negative impacts to people due primarily from the 35 percent DMP, it would be very inflexible, it would be the most expensive of all the Composite Programs, and it would have the most short-term negative construction impacts. It would maintain the District's all-Sierra supply.

1.4.3.2 Composite Program II (Groundwater). The ability to implement Composite Program II is uncertain due to institutional issues. If achievable, the implementation could be introduced in phases. It could have growth-inducing impacts in San Joaquin County. It is the second lowest cost and would have the fewest negative environmental impacts.

1.4.3.3 Composite Program III (Delta Supply). Composite Program III has questionable institutional viability over the 30-year planning period. It would be technically unreliable because of the potential for levee failure due to seismic shaking, it would add additional uncertainty regarding health risks associated with finished water quality, it would require complex treatment, it would be the second most expensive and would have potential negative impacts related to the brine disposal pipeline and outfall.

1.4.3.4 Composite Program IV (Groundwater and Folsom South Connection). Composite Program IV would provide an additional supply of water and therefore a more flexible and redundant water supply solution. It would be potentially growth-inducing in San Joaquin County, it could be flexibly implemented and it would be in the mid-range of costs, and would have few negative environmental impacts.

1.4.3.5 Composite Program V (Raise Pardee). Composite Program V would have a number of operational advantages to the District, assuming it could be implemented. These would be counterbalanced with a number of known environmental impacts, including recreational use of the reservoir and the free-flowing river upstream. It would be in the mid-range of costs.

1.4.3.6 Composite Program VI (Groundwater Only). Composite Program VI would have the lowest costs and few environmental impacts. It would be similar to Composite Program II in its implementation uncertainty.

Exhibit 1-5
Key Site-Specific Impact Distinctions (Page 2 of 2)

	I - Demand-Side Management	II - Groundwater	III - Delta Supply	IV - Groundwater and Folsom South Canal Connection	V - Raise Pardee	VI - Groundwater Only
Terrestrial Biological						
Wetlands, Botanical and Wildlife Impacts	Because of the potential to carefully locate most components, impacts could likely be avoided or minimized.	Because of the potential to carefully locate most components, impacts could likely be avoided or minimized.	Because of the potential to carefully locate most components, impacts could likely be avoided or minimized. Brine disposal pipeline could impact Suisun Marsh.	Because of the potential to carefully locate most components, impacts could likely be avoided or minimized.	Approximately 33 acres of "Waters of the U.S." would be inundated (approximately 31 acres are "other waters of the U.S." and 2 acres are wetlands). Approximately 890 acres of habitat would be flooded.	Because of the potential to carefully locate most components, impacts could likely be avoided or minimized.
Aquatic Biological						
Fisheries Impacts	All Composite Programs include the LMRMP commitments and except for impacts to reservoir fisheries, all Composite Programs would be similar for the Mokelumne River fishery.	All Composite Programs include the LMRMP commitments and except for impacts to reservoir fisheries, all Composite Programs would be similar for the Mokelumne River fishery.	All Composite Programs include the LMRMP commitments and except for impacts to reservoir fisheries, all Composite Programs would be similar for the Mokelumne River fishery. Withdrawals from the Delta could impact fish by entrainment or movement of the entrapment zone.	All Composite Programs include the LMRMP commitments and except for impacts to reservoir fisheries, all Composite Programs would be similar for the Mokelumne River fishery.	All Composite Programs include the LMRMP commitments and except for impacts to reservoir fisheries, all Composite Programs would be similar for the Mokelumne River fishery. Kokanee salmon spawning gravels, located in the upstream inundation area, would be reduced. Kokanee salmon are a food source for Bald Eagles.	All Composite Programs include the LMRMP commitments and except for impacts to reservoir fisheries, all Composite Programs would be similar for the Mokelumne River fishery.

1.4.2.4 Terrestrial Biological Impacts. For Composite Programs I and II, most components could be located to minimize or avoid impacts on wetlands, botanic or wildlife resources. Raise Pardee appears to be distinct in that it would inundate approximately 890 acres of botanic and wildlife habitat; no extraordinary negative impacts that could not be mitigated have been found at the program level of study. Approximately 33 acres of "Waters of the U.S." would be inundated (approximately 31 acres are "other waters of the U.S." and two acres are wetlands).

Composite Program III would require a 70-acre site. In addition, construction of the brine disposal pipeline would have potential impacts, including impacts on the salt marsh and other marshes near Suisun Bay.

1.4.2.5 Aquatic Biology. All Composite Programs include the LMRMP commitments and, consequently, all Composite Programs would have similar implications for the Mokelumne River fishery. Composite Program V would be distinctly different in that Kokanee salmon spawning grounds, located in the upstream inundation area, would be reduced.

Composite Program III - Delta Supply. Composite Program III would entail pumping at Bixler, which might have several important consequences for fish in the Delta. Potential impacts would include entrainment, impingement, water quality changes associated with Delta circulation patterns, disposal of brine wastes from desalination, and construction impacts. Of these, entrainment and impingement are considered of the greatest potential long-term significance. Entrainment is the passage of small pelagic organisms such as fish eggs and larvae through the pump intake screen. Impingement refers to the capture of aquatic organisms on the surface of the intake screen. They occur when organisms are drawn to the pumps by the artificial current. The significance of the impacts caused by these processes would depend on the type of intake structure, screens, and water velocity. Some technologies can reduce impacts substantially under some circumstances. Some life stages of fish, especially eggs and larvae, are especially vulnerable. Adult fish drawn towards the pumps can be collected and relocated away from the pumps, but such operations often cause significant mortality.

Of the many fish species resident in the Delta, several are currently of special concern. The thicktail chub is probably extinct. The delta smelt (*Hypomesus transpacificus*) was recommended for protected status in California in 1989 and the California Department of Fish and Game recommended listing it as threatened in 1990. The fish was denied protection by the California Fish and Game Commission, but its status is being reviewed by the U.S. Fish and Wildlife Service for federal protection. Delta smelt live in schools in open water in or near the entrapment zone. Spawning occurs in shallow fresh water, typically in dead end sloughs or

Section 6.4

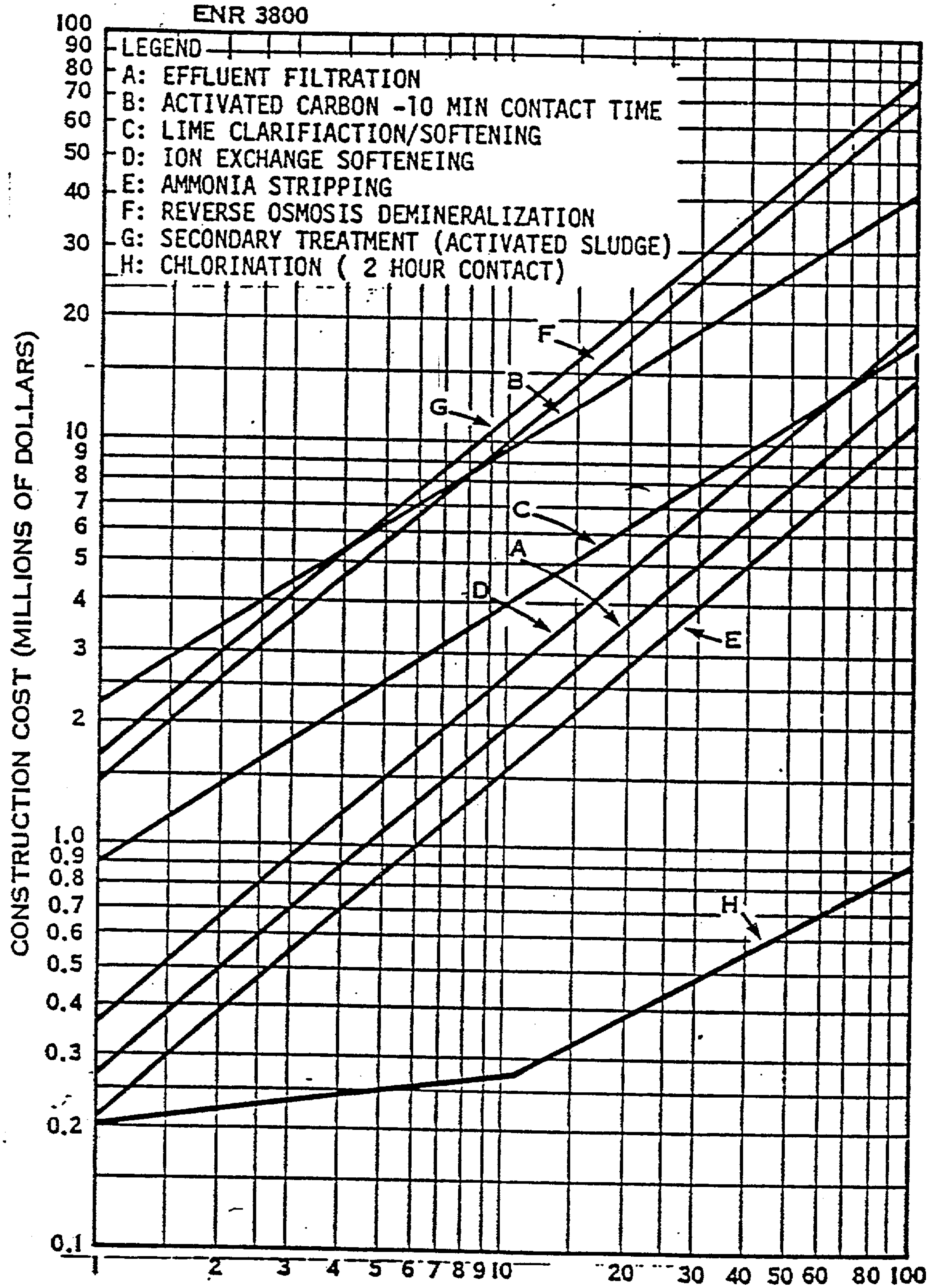
ENR CONSTRUCTION COST INDEX

Over the years, engineering firms and the EPA have produced cost curves comparing the capital and O&M costs to the size of treatment facility for various types of wastewater (primary, secondary and tertiary) treatment processes. These costs curves are generally conservative and tied to an Engineering News Record Construction Cost Index (ENR-CCI). There are also curves for the cost per unit of length for laying various types of sewer or water distribution pipe related to pipe diameter, depth to cover, presence of paving and other relevant factors. These curves can be useful in making a first approximation of the potential costs during the concept planning and feasibility level analysis before engineering design begins. Costs from the curves are escalated to the projected midpoint of construction based on the rate of change in the ENR-CCI. It is important at this stage to include a contingency factor of 20 to 50 percent (depending upon the degree of development of the conceptual design), in addition to the inclusion of the costs for engineering, inspection, profit and overhead (which may or may not be included in the estimating curves). During the engineering design phase, the design engineer should be in position to prepare more accurate cost opinions based on the actual site and design conditions. A typical set of curves is included for capital costs and for O&M. The historic ENR-CCI index for San Francisco and Los Angeles is also included.

ENR CONSTRUCTION COST INDEX 1973-1997

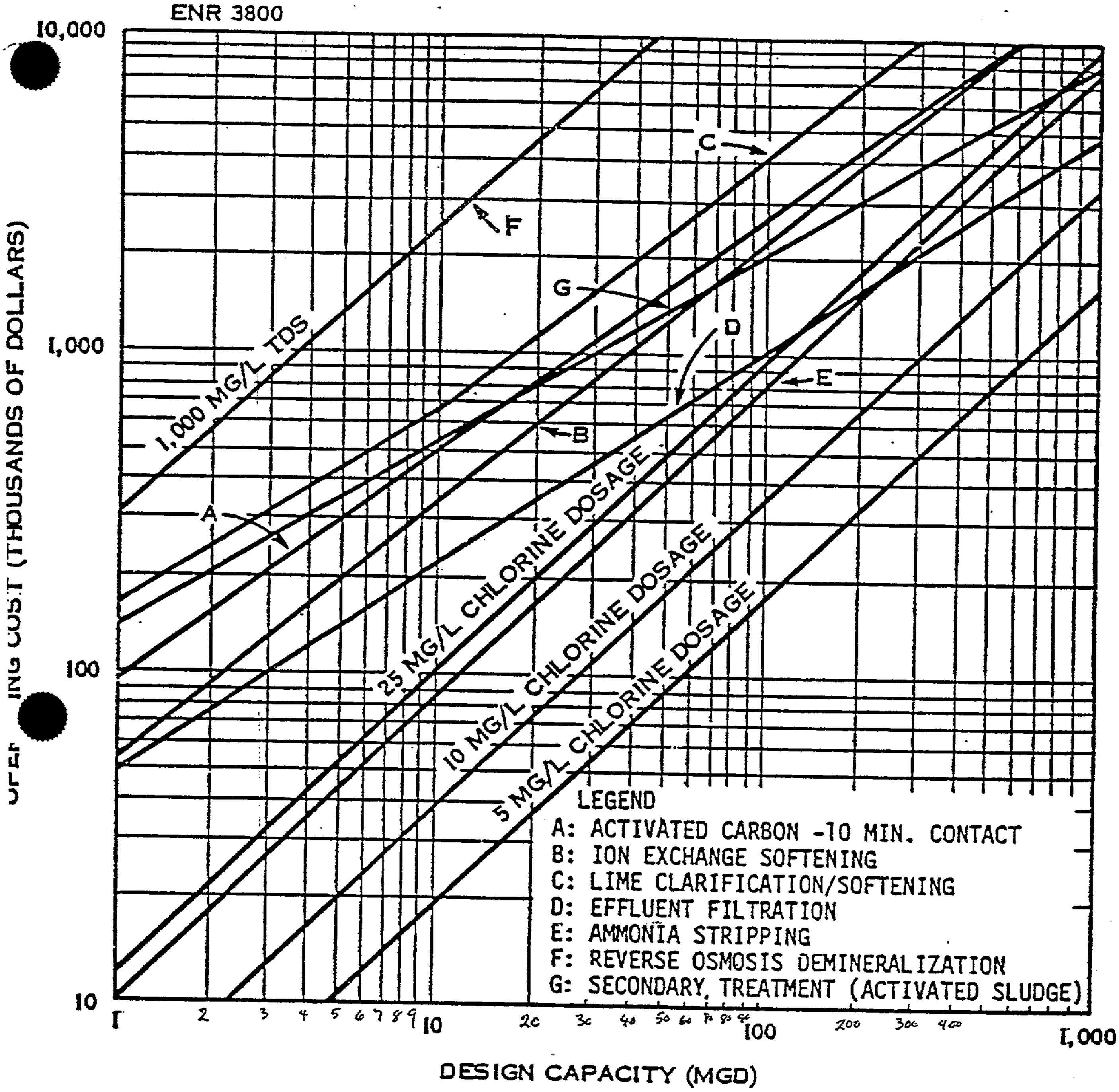
Year [1]	Los Angeles	San Francisco
1973	2099.18	2235.84
1974	2279.66	2508.50
1975	2585.93	2807.07
1976	2923.33	3104.02
1977	3161.75	3150.78
1978	3421.25	3412.20
1979	3638.81	3806.14
1980	4102.37	4371.96
1981	4530.96	4592.45
1982	4934.14	4993.30
1983	5063.89	5122.74
1984	5259.93	5049.13
1985	5446.69	5055.04
1986	5452.20	5508.43
1987	5474.14	5732.37
1988	5770.84	5734.48
1989	5789.77	5932.57
1990	5994.55	6055.61
1991	6090.12	6222.06
1992	6348.55	6294.84
1993	6477.84	6477.95
1994	6532.95	6530.35
1995	6526.22	6558.16
1996	6558.44	6629.61
1997	6663.55	6731.08

[1] Indexes from December.



FIGURE

CONSTRUCTION COSTS OF ADVANCED TREATMENT FACILITIES



FIGURE

OPERATING COSTS OF ADVANCED TREATMENT FACILITIES

Section 6.5

FORMULA FOR DETERMINING NET COST OF WATER REUSE

Net Present Value (Worth) Formula

A simple approach for determining the net cost is as follows:

1) Identify all costs and benefits

2) Measure and value all costs and benefits (some are estimates)

3) Discount costs and benefits over time to establish present worth

4) Analyze the uncertainty in the assumptions and estimates (sensitivity analysis)

One of the common issues in evaluating the costs and benefits of a water recycling project is the question of whose costs and benefits. Since the water supply system in California is basically interconnected, an acre-foot of recycled water use in San Diego impacts water availability in northern California.

At the customer level, the customer of recycled water is only concerned with whether it saves money versus potable water (plus drought proof, quality, and service issues). Customer groups include:

- Participating recycled water customers,
- Non-participating potable water customers (same retail water utility), and
- Wastewater system customers (rate payer subsidy issues).

The costs evaluation can also be viewed from the perspective of:

- The local water utility,
- The wholesale water utility,
- Statewide perspective, and
- Total Society Costs.

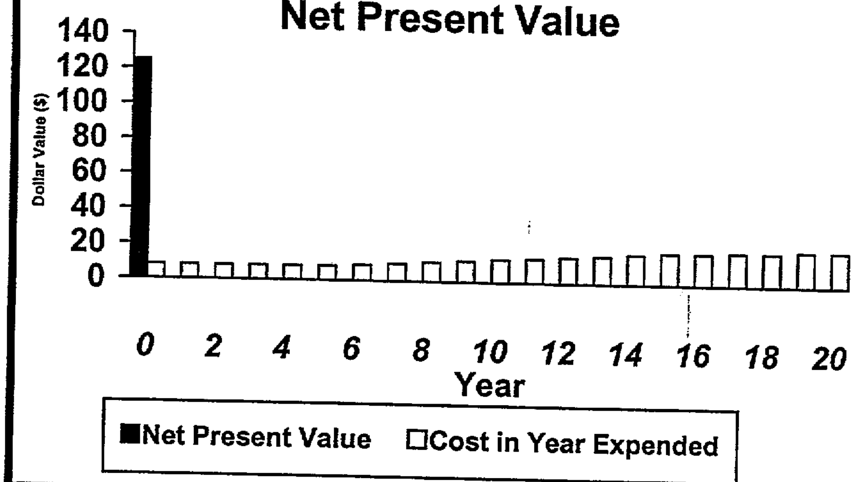
The fundamental equation to compare benefits and costs simply subtracts the present value of costs from the present value of benefits to get **Net Present Value (NPV):**

$$NetPresentValue = PresentValueBenefits - PresentValueCosts$$

The Net Present Value concept is illustrated in Figure 4-3 where the black bar represents the equivalent present value of the series of costs indicated by white bars over 20 years.

Although this equation is simple, identifying, measuring, and valuing the costs and benefits that occur each year can be difficult.

Figure 4-3
Net Present Value



For the purposes of evaluating a project, all costs and benefits should be considered. Developing a project concept report needed to implement a recycled water project should identify all the costs. For example, customers participating in a recycled water program may need retrofit plumbing installed.

Determining the benefits of a recycled water program, including the resources conserved derived from its implementation should identify benefits. For example, participating customers spend less to purchase water, which frees up money for other purposes. Water utility suppliers of imported groundwater avoid construction of new facilities. Society benefits from recycled water that saves energy and avoids environmental damage.

D R A F T

Present Worth Calculation

In order to provide a common basis for comparing costs and benefits of alternative projects, it is recommended that future costs and benefits be converted to Present Worth equivalents using appropriate time periods and interests rates. Present worth (or present value) can be established by using the formulas or tables available in most engineering economic texts to derive the Present Worth Factor (PWF) for either a single sum expended or received in some future year, "n" years from now, or a series of uniform annual payments or receipts. It may also be referred to as the "discount factor." Regardless of what it is called, it represents the amount of money "P", invested now at interest rate "i", which will appreciate to the sum "S", to be expended in year "n". In other words, P is the present worth of a payment of S, "n" years from now. For a single payment, it is obtained by multiplying S by the PWF for the applicable "n" and "i" under consideration. The formula for the PWF for a single payment is:

$$PWF = \frac{1}{(1+i)^n}$$

For a uniform annual series of payments, "R", over "n" years, PWF_R is:

$$PWF_R = \left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

As an example, if a recycling project expected to expand its facilities at a cost of $12 million dollars in 15 years from now and the average interest rate over the period is estimated to be 8 percent, the PWF would equal 0.3152.

The present worth "P" of that future expenditure is therefore:

P = $12,000,000 *x* 0.3152

P = $3,782,400

In this manner, other alternatives with different time frames and amounts for future expenditure can be compared on a uniform basis.

PRESENT WORTH FACTORS

n	Interest (*i*)					
	5%	6%	7%	8%	9%	10%
0	1.00	1.00	1.00	1.00	1.00	1.00
1	0.95	0.94	0.93	0.93	0.92	0.91
2	0.91	0.89	0.87	0.86	0.84	0.83
3	0.86	0.84	0.82	0.79	0.77	0.75
4	0.82	0.79	0.76	0.74	0.71	0.68
5	0.78	0.75	0.71	0.68	0.65	0.62
6	0.75	0.70	0.67	0.63	0.60	0.56
7	0.71	0.67	0.62	0.58	0.55	0.51
8	0.68	0.63	0.58	0.54	0.50	0.47
9	0.64	0.59	0.54	0.50	0.46	0.42
10	0.61	0.56	0.51	0.46	0.42	0.39
11	0.58	0.53	0.48	0.43	0.39	0.35
12	0.56	0.50	0.44	0.40	0.36	0.32
13	0.53	0.47	0.41	0.37	0.33	0.29
14	0.51	0.44	0.39	0.34	0.30	0.26
15	0.48	0.42	0.36	0.32	0.27	0.24
16	0.46	0.39	0.34	0.29	0.25	0.22
17	0.44	0.37	0.32	0.27	0.23	0.20
18	0.42	0.35	0.30	0.25	0.21	0.18
19	0.40	0.33	0.28	0.23	0.19	0.16
20	0.38	0.31	0.26	0.21	0.18	0.15
21	0.36	0.29	0.24	0.20	0.16	0.14
22	0.34	0.28	0.23	0.18	0.15	0.12
23	0.33	0.26	0.21	0.17	0.14	0.11
24	0.31	0.25	0.20	0.16	0.13	0.10
25	0.30	0.23	0.18	0.15	0.12	0.09